MARINE ENGINEERING.

Vol. 5. NEW YORK, AUGUST, 1900. No. 8

MAIDEN TRIP OF THE HAMBURG-AMERICAN S. S. DEUTSCHLAND.

In MARINE ENGINEERING for July were published views of the engines, boilers and crank shaft of the new Hamburg-American liner *Deutschland*. The long looked for maiden trip has now been run, and a new set of records has been established. The contract for the ship called for a speed of 23 knots and it seems not too much to believe that this figure as an average speed will be not only reached but even exceeded when the machinery has become adjusted and settled into good working condition.

HAMBURG-AMERICAN COMPANY'S TWIN SCREW S. S. DEUTSCHLAND.

The *Deutschland* left Plymouth on July 6, at 10.51 P. M., and arrived off Sandy Hook on July 12, at 10.15 A. M. The total distance run was 3,044 knots and the average hourly speed 22.42 knots. The daily runs were as follows: 308, 557, 553, 551, 532, 543. There are no records from Plymouth to Sandy Hook, but the distance run is almost the same as that covered on the maiden trip of the *Kaiser Wilhelm der Grosse* from the Needles to Sandy Hook—3,050 miles, which required 5 days, 22 hrs., 35 mts., giving an average speed of 21.39 knots. The *Deutschland* has also beaten the best western run of the *Kaiser Wilhelm der Grosse* which was made in November last from Cherbourg to Sandy Hook at an average speed of 22.19 knots.

On the home run eastward the results were still more gratifying, and new records in this direction have also been established. The distance run from Sandy Hook to Plymouth was 3,085 knots, and the time was 5 days, 14 hrs., 6 mts., giving an average speed of just 23 knots for the trip. The daily runs were as follows: 536, 534, 515, 530, 535 and 435. The previous Sandy Hook-Plymouth record eastward had been held by the *Kaiser Wilhelm der Grosse*, made on her first trip in October, 1897. The time then required was 5 days, 15 hrs., 10 mts., over a distance of 2,962 knots, giving an average speed of 21.91 knots. The new record betters the time by 1 hr. and 4 mts., over a slightly longer course, making a gain of 1.09 knot average speed for the run.

It thus appears that the *Deutschland*, with her displacement of 23,000 tons and speed of 23 knots, represents a notable advance in fast ocean steamships, and her career in the immediate future, or until her laurels shall be transferred to some new ocean wonder, will be watched with the liveliest interest.

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FAST PASSENGER STEAMER ANGLIA.

In the accompanying photographs of the S. S. *Anglia*, the most recent addition to the extensive fleet of the London & Northwestern Railway, operating in the Irish Sea, is shown. For many years the paddle steamer held its own in those waters to the exclusion of screw vessels, but since the handiness and economy of the twin-screw vessel have come to be recognized by the conservative officials of the various lines, the modern type has rapidly displaced the older side-wheeler. The latter did not succumb without a fierce struggle, and this has been the cause of vessels with single expansion engines and about 30 lb. steam pressure running in the same service with vessels fitted with triple-expansion engines and modern high pressure boilers.

The service which the vessel shown is engaged in is the carriage of passengers from the port of Dublin to the terminus of the London & Northwestern Railway at Holyhead, across the Channel in Wales.

The new vessel is a product of the famous Denny Yard, at Dumbarton-on-the-Clyde. She is a twin-screw vessel, built of mild steel, of these dimensions: Length, 337 ft. 6 in.; beam molded, 39 ft.; depth to awning deck, 24 ft. 9 in.; draft, 11 ft. 9 in.; tonnage, 1,862 tons. It will be seen that the draft is light. This is occasioned by shallow water at both ends of the run, and the chief difficulty, perhaps, to be overcome by the designer, was to get the required high speed within these limitations. On her trial trip on two separate runs of 100 knots, a mean speed of 21.5 knots was attained. In her regular service the cross-Channel passage is about 64 knots, and the rate of speed not less than 20 knots. On her first cross-Channel trip the wind was exceedingly strong on the port quarter and the sea very rough," and the rate of speed was 20.5 knots, with 178 engine revolutions per minute—the same as on the trial which took place in smooth water. On the trial trip the boiler pressure was 160 lbs. and the I. H. P. developed 7,000. The propelling engines are of the four-cylinder triple-expansion type, balanced on the Schlick-Yarrow-Tweedy system.

Outside of the machinery spaces the entire vessel is practically occupied by passenger accommodations, with furnishings and fittings such as are usual in British coastwise steamers of this class.

MAIN SALOON, S. S. ANGLIA.

SECOND-CLASS SALOON, S. S. ANGLIA.

EQUIPMENT FOR HANDLING BULK CARGOES RAPIDLY AT GREAT LAKE PORTS.—II.*

BY ARTHUR C. JOHNSTON.

When railway cars are always available "direct unloaders" are used to transfer the ore directly to cars. The latest plant of this kind is that shown in Fig. 9 and in Fig. 10, built by the McMyler Mfg. Co. for the Pittsburg and Conneaut Dock Company, at Conneaut, Ohio. These machines have attracted a great deal of attention and a description of their equipment will be of interest. Each machine, complete in itself, carries three bridges, which can be racked in and out to suit any spacing of hatches from 21 to 36 ft. centres. The bridges cover five loading tracks, and are high enough to accommodate the largest Lake vessels. An 80 H. P. locomotive type boiler supplies steam to three pairs of 10 1-2 in. by 14 in. reversing engines. Each pair of engines has 40 in. drums for both hoisting and trolleying, mounted on the crank shaft, the wagon having a three part hoist. A feature of the arrangement of the engine is the method of controlling the clutch and brake for the trolleying drum—using a steam cylinder, which when it sets the brake at the same time releases the clutch, and vice versa. Cables 9-16 in. dia. are used for hoisting, running on 24 in. sheaves except in the wagon where they are 17 in. and in the hanging block 15 in. dia. It is made impossible for a rope to leave the sheave by the use of the very simple guard shown in Fig. 11. The machines can travel along the dock by steam and the racking of bridges is also effected by the engines. All movements other than hoisting and trolleying of the bucket are accomplished by means of a jack shaft driven by a pinion on the crank shaft of the main engines. Under actual working conditions the capacity of the plant of twelve bridges at Conneaut is 6,000 gross tons per day.

Fig. 12 is a photograph of a similar direct unloading plant built by the Brown Hoisting and Conveying Machine Company on the C. & P. docks at Cleveland. The drum is geared to the crank shaft and the "suspended hook" is used. In neither the Brown nor the McMyler direct unloaders is the hanging block locked in the wagon except to obtain the maximum clearance under the bucket. The lock on the wagon is very handy, however, to hang empty buckets from when the machine is idle.

FIG. 9. MCMYLER DIRECT UNLOADER.

With all these machines in which the buckets are filled by hand, the actual cost of handling the buckets is very small, varying according to how nearly up to its full capacity a machine is worked; but under actual working conditions from figures prepared by A. E. Brown, the cost per gross ton of ore handled by his machine varies from .70 cents to 1.37 cents. But the greatest expense is incurred in filling the buckets. The shovelmen are paid from 10 1-2 cents to 13 cents per gross ton, so that at an average rate of 11 cents per ton it cost $1,980,000 for shoveling, to unload the 18,000,000 tons of ore shipped this year. It was to re-

*A paper read before the Civil Engineers' Club of Cleveland and contained in the Journal of the Association of Engineering Societies.

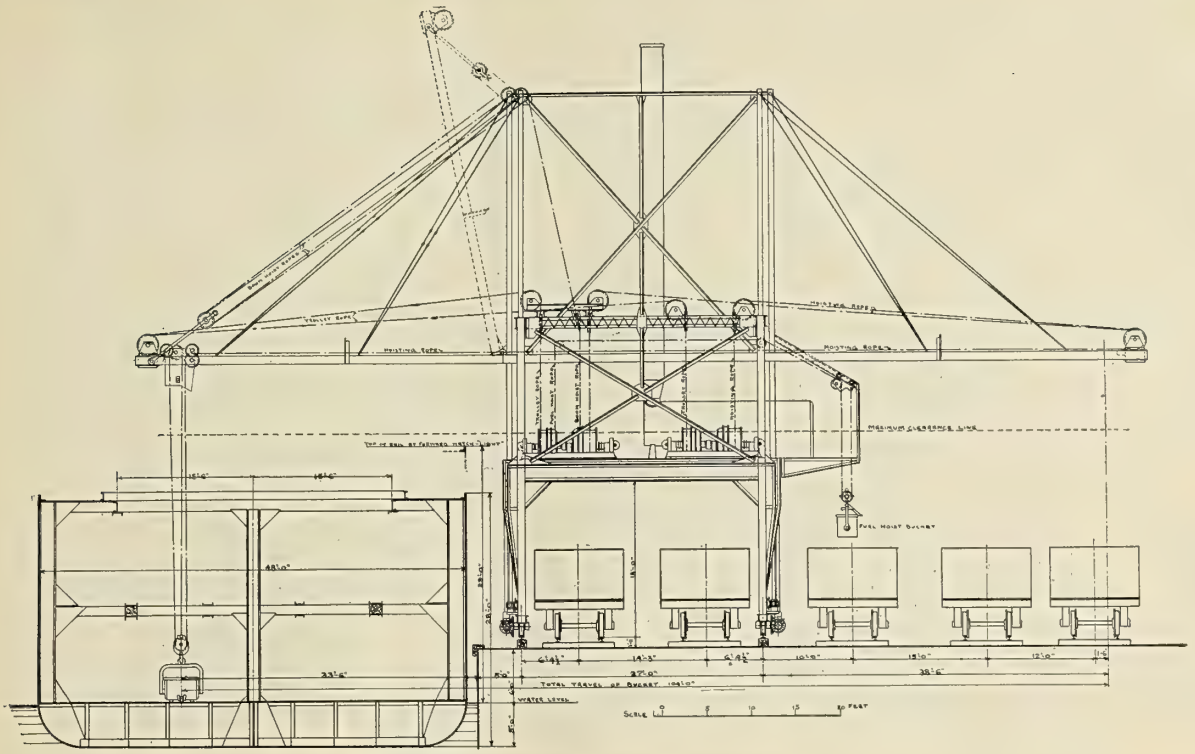


FIG. 10. McMYLER DIRECT UNLOADER.

duce this cost that the Hulett ore unloader shown in Figs. 13 and 14 was designed and built by the Webster, Camp and Lane Machine Company for the Pittsburg and Conneaut Dock Company at Conneaut. Up to the present not enough has been done with this machine to obtain any data in regard to its performance. Its method of operation will be evident, however. The bucket is designed to lift 10 tons of ore at one scoop and dump it into the railway cars, or into a skip which can deliver it onto the stock piles. All the motions on the trolley carrying the tilting girder are effected by hydraulic power—the pumps and tank being carried in the trolley itself and the steam loaded accumulator is used to partly balance the weight of the bucket. The operator is located just above the bucket, and descends into the hatch with it. The bucket can rotate in either direction about the axis of the vertical ram, thus enabling the ore lying in between

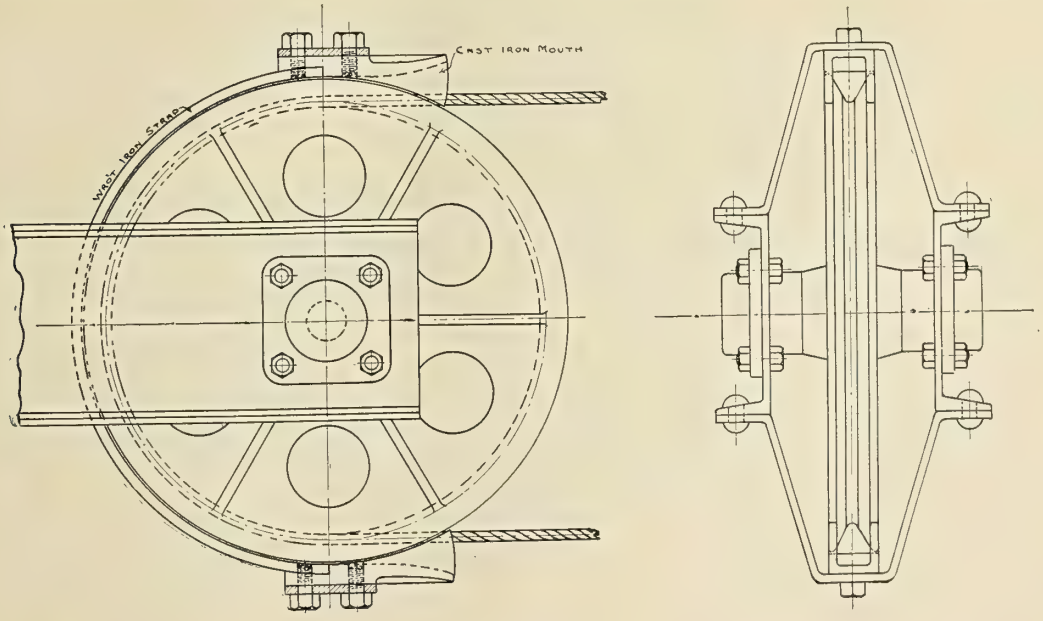


FIG. 11.

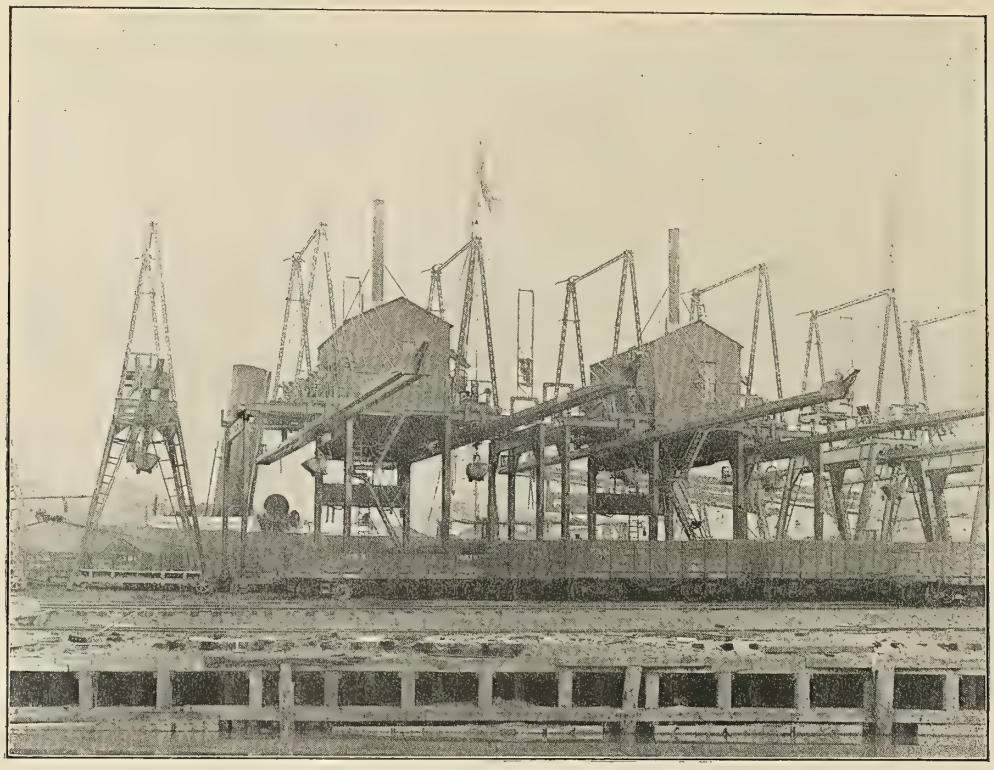


FIG. 12. BROWN DIRECT UNLOADER.

hatches to be reached. It is expected that very little of the ore will have to be shoveled by hand with this machine.

The large vessels returning from the lower lake ports go up in water ballast or take a return cargo of coal, and to facilitate the loading of the enormous tonnage that is carried to the upper lake ports each year, the car dumper has been developed—a machine which picks up bodily a car weighing 17 1-2 tons and carrying 40 tons of coal, and empties the contents into the hold of a vessel at the rate of as high as 30 cars per hour. Fig. 15 shows the first type of McMyler "side dump" machine

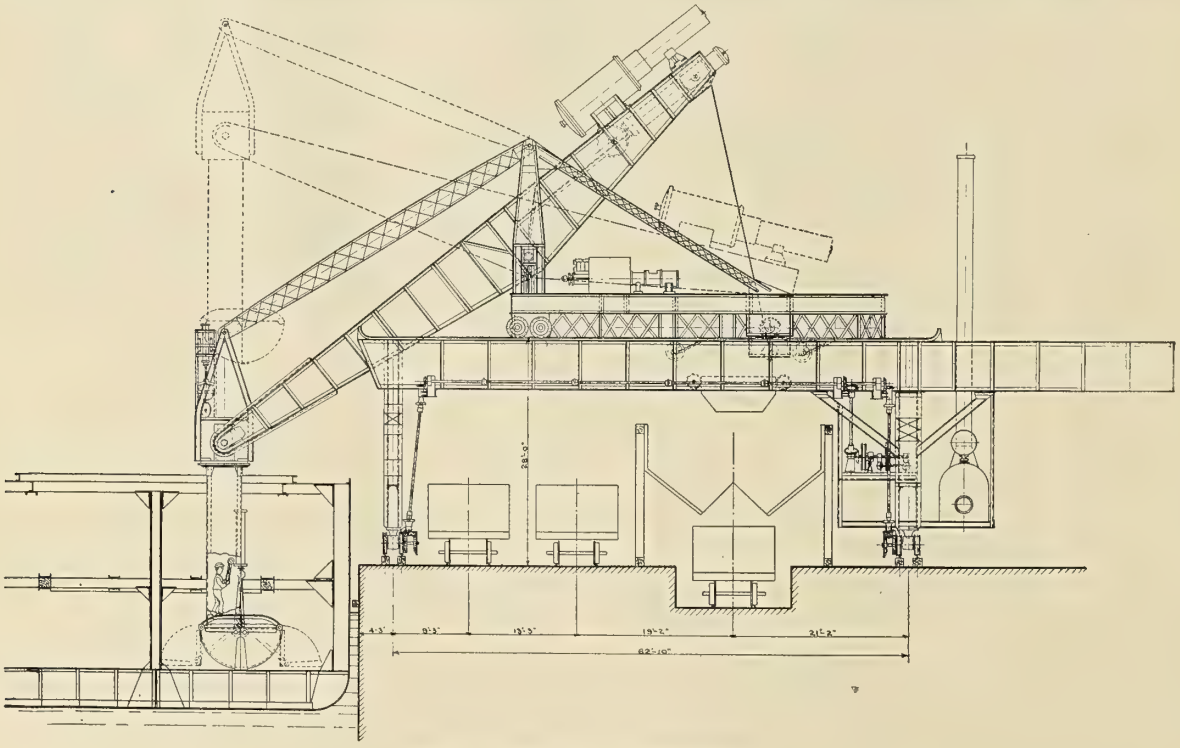


FIG. 13. HULETT ORE UNLOADER.

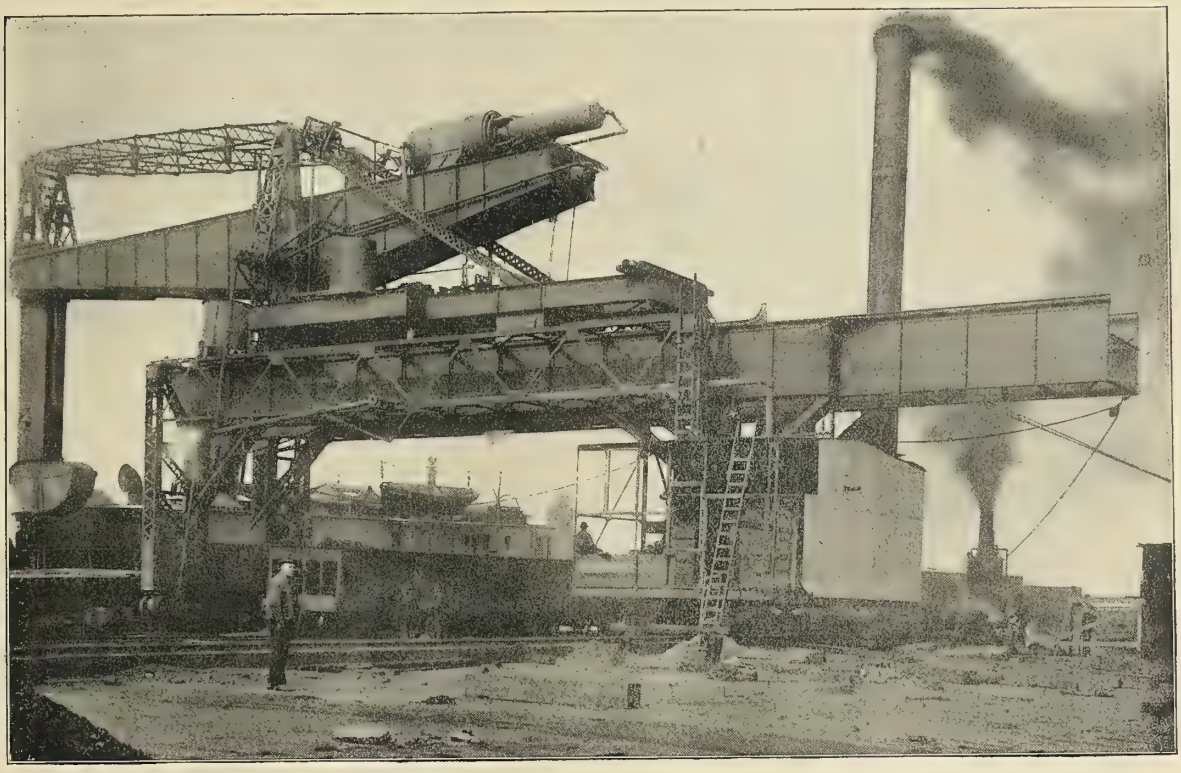


FIG. 14. HULETT ORE UNLOADER.

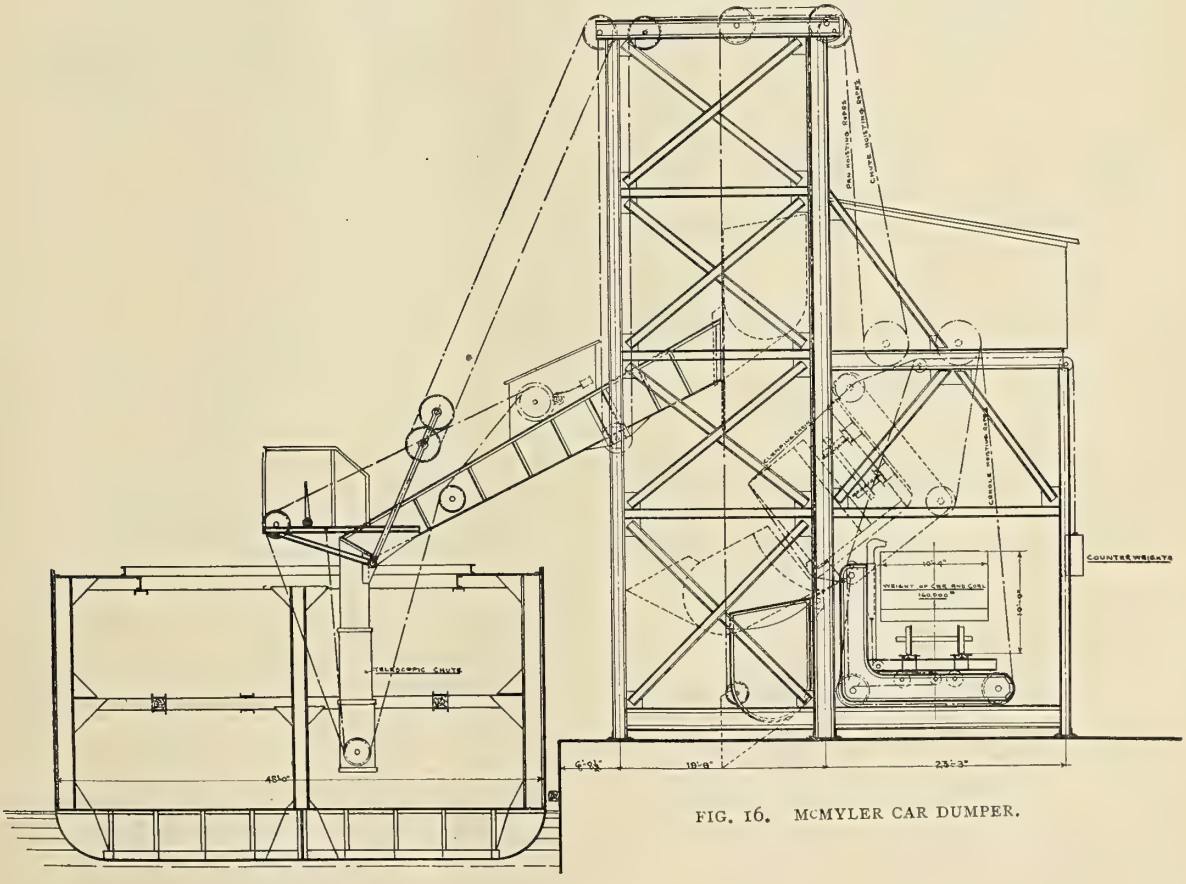


FIG. 16. McMYLER CAR DUMPER.

built on the lakes. The first successful machines were of the "end dump" type, but they require special cars and are still in operation, one at Ashtabula and one at Fairport. The machine shown in Fig. 15 is very flexible in operation, as the hinges of the aprons may be raised or lowered vertically to suit any class of vessel, and the car and cradle in ascending begin to turn over on striking the hinge point of the apron. This machine has been built with several types of chutes, but the most successful perhaps is the telescopic chute shown, as by its use much trimming of cargo is

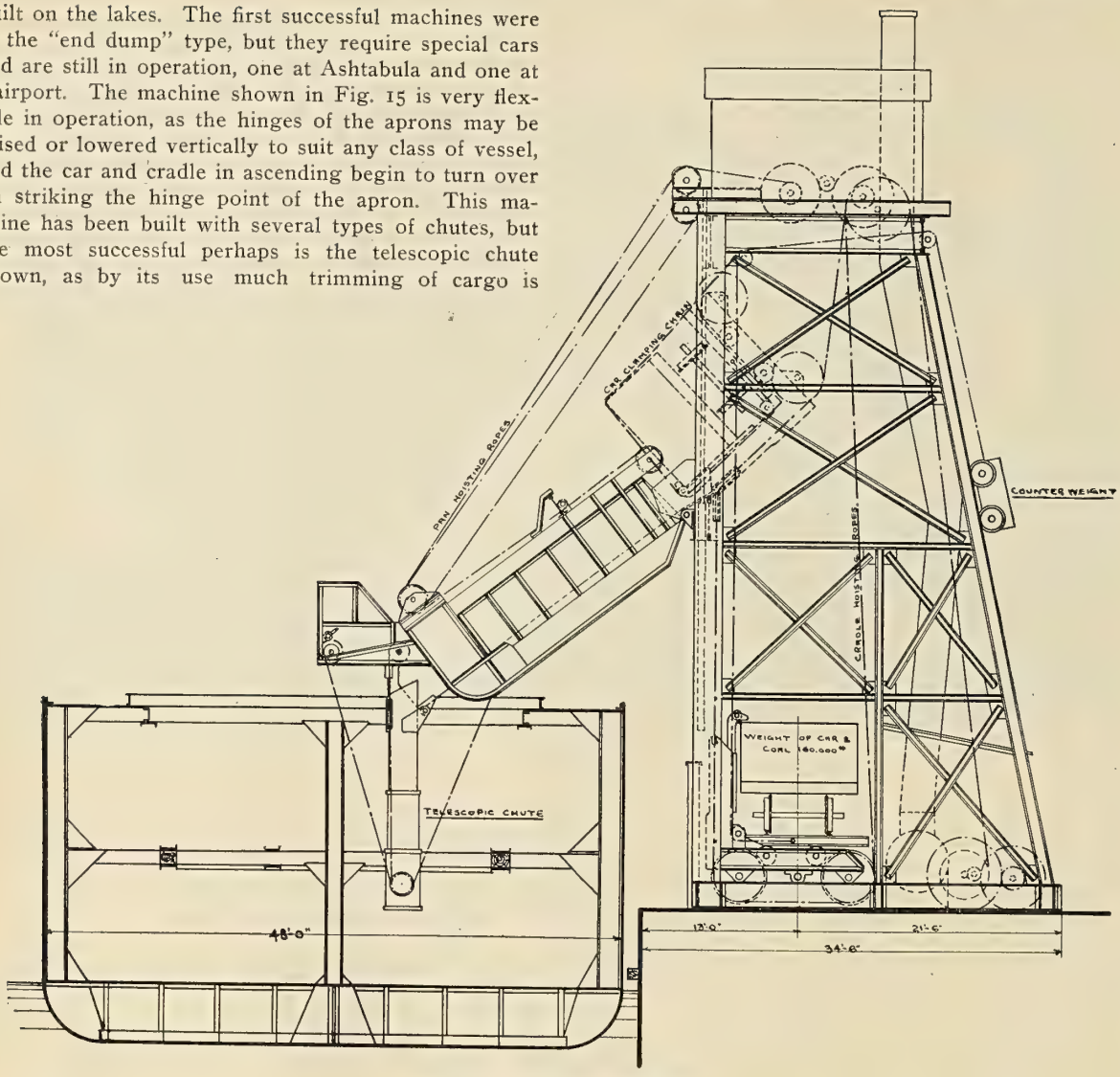


FIG. 15. MCMYLER SIDE DUMP.

avoided. The car clamping mechanism is beautifully simple, being merely four chains with counterweights suspended, the chains wrapping round the car as it is overturned. The cable is hoisted by four 1 1-4 in. cables arranged as a "two part" hoist on 45 in. drums driven through double reduction gearing by a pair of 14 in. by 18 in. engines. The load is lowered by using the engines as air pumps and throttling the exhaust, or with a foot brake, as desired. In operation the machine, though so powerful, is extremely simple, considering the work it accomplishes, and has a record of 32 cars an hour, but of course this speed cannot be maintained on account of delays in switching cars and shifting the boat to reach different hatches. There are three machines of this type in operation. One on the docks of the Cuddy-Mullen Coal Company at Cleveland, one on the docks of the Cleveland Terminal & Valley Ry. at Cleveland, and one at Erie, Pa., on the docks of the Erie and Pittsburg Ry.

Fig. 16 shows the latest type of McMyler car dumper designed to handle the coal more gently in order to reduce the breakage to as small a percentage as possible. There are also three of these machines in operation; one operated by the Pittsburg and Conneaut Dock Company at Conneaut, Ohio, another by The Cleveland, Lorain & Wheeling Ry. at Lorain, and a third at Ashtabula. As will be seen in the engraving, the coal is first dumped into a pan, which is partly overturned to receive it as it rolls out of the car. The pan is then hoisted, the car being lowered meanwhile—until the chute is reached, when a door in the pan opens automatically and discharges the coal into the chute. This machine is also very fast and handles regularly under working conditions 1,000 tons of coal per hour. All the motions with the exception of hauling the cars onto the cradle are performed by a single pair of 16 in. by 18 in. engines. The car and cradle are hoisted by eight 1 1-8 in. cables on 60 in. drums geared to the crank shaft by single reduction gearing. The operations of hoisting and tipping the pan are accomplished by sixteen 1 in. ropes on four drums 40 in. dia. The unit stresses specified by the P. & C. Dock Co.'s specifications covering this machine were as follows:

UNIT STRESSES.

Direct tension machinery steel in structural work, 10,000 $\left(1 + \frac{\text{Min.}}{2\ \text{Max.}}\right)$.

Tension flanges of built girders, 8,000 $\left(1 + \frac{\text{Min.}}{2\ \text{Max.}}\right)$.

Tension flanges of symmetrical rolled sections, 10,000 $\left(1 + \frac{\text{Min.}}{2\ \text{Max.}}\right)$.

Direct compres'n, $\left(10{,}000 - 30\frac{l}{r}\right)\left(1 + \frac{\text{Min.}}{2\ \text{Max.}}\right)$.

Maximum limiting value for direct compression, $\frac{l}{r} = 120$.

l = length of member in inches.

r = least radius of gyration in inches.

Unstayed length of flanges for built beams, $\frac{l}{w} = 16$.

Unstayed length of flanges for rolled beams, $\frac{l}{w} = 20$.

l = length of unstayed flange in inches.

w = width of flange in inches.

MACHINERY SPECIFICATIONS.

Babbitted Bearing Pressures—

For steady pressures, pressure per square inch × velocity of journal in feet per minute must not exceed 60,000.

For intermittent pressures use 120,000.

For slow-moving bearings (not over 100 ft. per minute) use 600 lbs. per square inch.

Chain and Rope Sheaves and Drums—

For link chains: $\frac{\text{Dia. of sheave}}{\text{Dia. of chain}}$ not less than 18.

$\frac{\text{Dia. of drum}}{\text{Dia. of chain}}$ not less than 24.

Ropes: $\frac{\text{Dia. of rope}}{\text{Dia. of sheave}}$ not greater than 1-30.

$\frac{\text{Dia. of rope}}{\text{Dia. of drum}}$ not greater than 1-45.

For all sheaves: $\frac{\text{Dia. of pin}}{\text{Dia. of sheave}}$ not greater than 1-7.

(To be Continued.)

Seventy war ships are under construction or have their designs in preparation for the United States Navy. Of this number there are twelve battleships, six armored cruisers, nine protected cruisers, four monitors, one gunboat, sixteen torpedo boat destroyers, fifteen torpedo boats, and seven submarine boats. Including with these the ships already in commission or ready for use, the fleet of the United States will consist of the following: Battleships, 18; armored cruisers, 8; cruisers, 16; monitors, 9; gunboats, 26; torpedo boats, 51; submarine boats, 7; special service, 25. The above numbers include the small Spanish gunboats and a fair representation of those converted from yachts during the recent war with Spain. The list of boats for special service includes a certain number of cruisers refitted from merchant steamers; also colliers, distilling, supply and hospital ships, dispatch boats, etc.

THE NAVAL STEAM ENGINE—ITS GRAPHICS AND ECONOMICS ILLUSTRATED—IV.

BY ROBERT H. THURSTON.

THE IDEAL CASES OF THE STARBOARD ENGINES

From the H. P. cards for the starboard engine, the average cut-off was found to be 47 per cent.

Carnot Cycle:

$p_1 = 150.8\#$ p. sq. in. $= 21{,}700\#$ p. sq. ft.

$p_2 = 5.8\#$ p. sq. in. $= 835\#$ p. sq. ft. (from indicator diagrams.)

$v_1 = 2.95$ cu. ft. per lb. steam.

$v_2 = 2.95\ (21{,}700 / 835).881 = 2.95 \times 13.32\frac{1}{8} = 39.3$ cu. ft. per lb.

$T_1 = 819°.6$. $T_2 = 629°.6$. $L_1 = 861.7$ *B. T. U.*

$r = 39.3 / 295 = 13.32$.

$H_1 = 778\ (1191.2 - 95.3) = 853{,}000$ ft. lbs.

Eff. $= (819.6 - 629.6) / 819.6 = 23.2\%$.

$U = 853{,}000 \times .232 = 198{,}000$ ft. lbs.

$A = 2{,}545 / .232 = 10{,}970$ *B. T. U.* per *H.P.* per hr.

$C = 1{,}980{,}000 / 853{,}000 \times .232 = 10.01$ lbs. steam per *H.P.* per hr.

Rankine Jacketed Cycle.

$r = 7.34$ (from indicator and data.)

$p_1 = 21{,}700$. $p_3 = 835$. $v_1 = 2.95$ cu. ft.

$v_2 = 2.95 \times 10.16 = 21.64$ cu. ft.

$p_2 = 2{,}530$. (from steam table). $T_1 = 819°.6$. $T_2 = 666°.1$.

$T_4 = 127.3 + 461 = 588°.3$.

$H_1 = 778\ (1{,}191.2 - 95.3) = 853{,}000$ ft. lbs.

$H_1' = 778\ (666.1 - 588.3) + 1{,}117{,}850\ (1 + \log_e 819.6 / 666.1) - 544.5 \times 819.6 = 60{,}500 + 1{,}349{,}000 - 446{,}000 = 963{,}000$ ft. lbs.

$U = 1{,}117{,}850 \times .207 - 544.5\ (153.5) + 21.64\ (1{,}695) = 231{,}400 - 83.540 + 35{,}800 = 183{,}660$ ft. lbs.

Eff. $= 183{,}660 / 963{,}500 = 19.04\%$.

$A = 2{,}545 / .19 = 13{,}360$ *B. T. U.* per *I.H.P.* per hr.

$C = 1{,}980{,}000 / 853{,}000 \times .19 = 12.20$ lbs. st. p. *I.H.P.* per hr.

$F = 13{,}360 / 10{,}000 = 1.34$ lbs. fuel per *I.H.P.* per hour.

Cylinder Condensation:

In calculating this internal waste it is assumed that it takes place entirely in the *L. P.* cylinder. Expressed algebraically:

$W = CA\ (T_1 - T_2)\sqrt{t}$, where $C = .000333$, $A =$ sq. ft. and $t =$ seconds.

The values of A were calculated from the dimensions of the engine.

Area cyl. head	=	42.2 sq. ft.
" piston	=	42.1 " "
" cyl. wall	=	59.4 " "
" piston rod	=	4.22 " "
Total	=	147.9 " "

Add 15% for ports $= 147.9 + 22.2 = 170.12$, total. $T_1 = 247.9°$. $T_2 = 168.7°$. $t = 60 / 252 = .238$.

$W = .00033 \times 170.12 \times 79.2 \times \sqrt{.238} = 2.12$ per stroke.

No. of strokes per hr. $= 126 \times 2 \times 60 = 15{,}120$.

I. H. P. $= 4{,}700$.

W per *I. H. P.* per hr. $= 2.12 \times 15{,}120 / 4{,}700 = 6.83$ lbs.

External Waste:

The waste by conduction and radiation is assumed sometimes at from 2.5 per cent to 5 per cent of the total heat supplied. We found this to be too high, considering the radiation from the cylinder wall to be 0.5 *B. T. U.* per sq. ft. per degree difference of temperature between the cylinder and the engine-room, and that the radiation from the cylinder heads is 2.5 *B. T. U.* This external loss is the same for each engine and was calculated as follows:

Area cylinder heads = 400 sq. ft.
" " sides = 200 " "
Range of temperature = 260 — 100 = 160.
200 × 160 × .5 = 16,000.
400 × 160 × 2.5 = 160,000.
16,000 + 160,000 = 176,000 *B. T. U.* per hour.
176,000 / 4,700 = 37.5 *B. T. U.* p. *I. H. P.* per hr.

Friction Loss:

The friction loss is assumed to be 12.5 per cent in each case.

The remainder of the calculations for this engine are given in the tabular statement at the end of the paper. They are obvious in their derivation.

THE IDEAL CASES OF THE PORT ENGINE.

Carnot Cycle:

$p_1 = 21{,}500$. $p_2 = 1{,}010$. $v_1 = 2.98$ cu. ft.
$v_2 = 2.98\,(p_1 / p_2).881 = 2.98 \times 15.12 = 45$ cu. ft.
$r = 15.12$.
$T_1 = 818°.7$. $T_2 = 637°.9$.
$H_1 = 778\,(1{,}191 - 95.3) = 853{,}000$ ft. lbs.
Eff. = 22.15%.
$U = 853{,}000 \times .2215 = 189{,}500$ ft. lbs.
$A = 2{,}545 / .2215 = 11{,}500$ *B.T.U.* per *I.H.P.* per hour.
$C = 1{,}980{,}000 / 853{,}000 \times .2215 = 10.43$ lbs. per *I.H.P.* per hr.

Rankine Jacketed Cycle:

$r = 7.49$. $v_1 = 2.98$ cu. ft. $v_2 = 22.3$ cu. ft.
$p_1 = 21{,}500$. $p_3 = 1{,}010$. $p_2 = 2{,}540$.
$T_1 = 818°.7$. $T_3 = 681°.9$, $T_4 = 588.3$.
$H_1 = 853{,}000$ ft. lbs.
$H_1' = 778 \times 93.6 + 1{,}117{,}850 \times 1.182 - 544.5 \times 818.7 = 948{,}000$ ft. lbs.
$U = 1{,}117{,}850 \times .182 - 544.5 \times 136.8 + 22.3 \times 1{,}510 = 163{,}300$ ft. lbs,
Eff. = 163,300 / 948,000 = 17.2%.
$A = 2{,}545 / .17.2 = 14{,}800$ *B.T.U.* per *I.H.P.* per hr.
$C = 1{,}980{,}000 / 853{,}000 \times .172$
= 13.5 lbs. st. per *I.H.P.* per. hr.
$F = 1.48$ lbs. fuel per *I.H.P.* per hr.

Cylinder Condensation:

$A = 170.12$. $T_1 = 247°$. $T_2 = 176°$. $t = .238$ sec.
$W = .00033 \times 170 \times (247 - 176 \times \sqrt{.238} = 1.95$ lbs. per stroke W per *I.H.P.* per hr. $= 1.95 \times 15{,}120 / 4{,}470 = 6.64$ lbs.

External Waste:

= 176,000 / 4,470 = 39.4 *B.T.U.* per *I.H.P.* per hr.

Actual Water Rate:

Lbs. of coal burned per hour, both engines, = 20,272.
" " water evp. " " " " = 182,448.
I.H.P. of all machinery (including auxiliaries) = 9,300.
" " two engines = 9,170.

Water per *I.H.P.* per hr. (engines) $= \frac{182{,}44}{9{,}170} \times \frac{9{,}170}{9{,}300} =$ 19.6 lbs.

Diagram Water Rate:

The water-rate at cut-off, per diagram, was computed as follows: Starboard Engine—

Equivalent *M.E.P.* for *H.P.* cylinder,
$= 55.24 + (20.7 \times \overline{57^2/35.5^2}) + 16.9 \times \overline{88^2/35.5^2}$.
$= 55.24 + 53.3 + 104 = 212.5$.
Abs. press. at cut-off = 126.
Abs. press. at end of compression = 100.
Diagram water rate = 14.6 lbs.

Port Engine—
Equivalent *M.E.P.* for *H.P.* cylinder
$= 49.6 + 21.5 \times \overline{57^2/35.5^2} + 16.8 \times \overline{88^2/35.5^2}$.
$= 49.6 + 55.6 + 103.8 = 212$.
Abs. press. at cut-off = 127.
" " " end of compression = 110.
Diagram water-rate = 14.7.

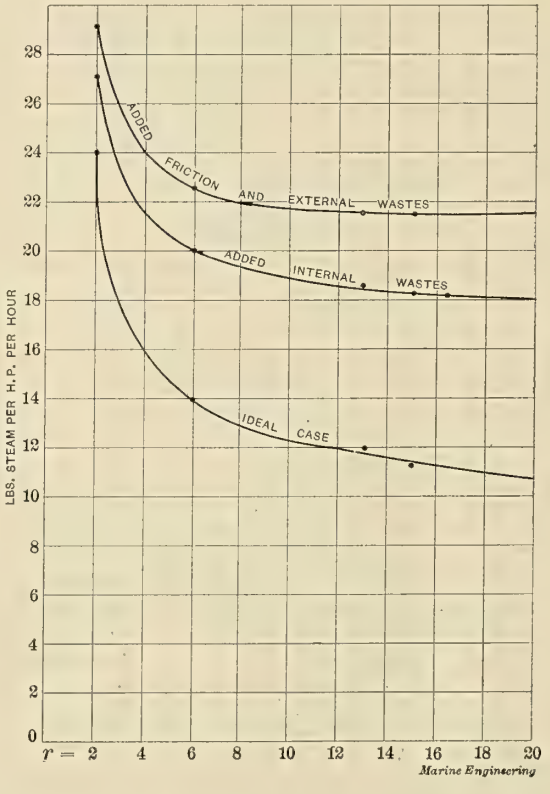
Following will be found the tabulated results:

The curves given show the variation of water-rate with increasing ratios of expansion, for the ideal case, and the added amounts for internal and external wastes.[6]

TABLE V.

U. S. S. MAINE.

	Ideal.		Real.	
	Star.	Port.	Star.	Port.
Lbs. steam p. *I. H. P.* p. hr.	12.20	13.5	19.6	19.6
B. T. U. p. *I. H. P.* p. hr.	13,360	14,800	21,420	21,420
Condensation, st. p. *I. H. P.* p. hr.			6.83	6.64
" *B. T. U.* p *I. H. P.* p. hr.			8,540	8,000
" % energy supplied	35.	32.	34 8	32.5
Thermodynamic efficiency	19 04	17.2		
Efficiency, Carnot cycle	23.2	22 15		
B. T. U. p. *I. H. P.* p hr. (Carnot)	10,970	11,500		
Fuel p. *I. H. P.* p. hr.	1.34	1.48	2.18	2.18
Exterior radiating surface			600	600
Exter. waste *B. T. U.* p. *I. H. P.* p. hr.			37 5	37 5
Lbs. steam p. *D. H. P.* p. hr.	13.93	15.4	22 4	22.4
B. T. U. " "	15,280	16,910	28,000	28,000
Condensation, st. p. *D. H. P.* p. hr.			7.7	7 32
" *B. T. U.* p. *D. H. P.* p. hr.			9,620	9,030
Lbs., st. p. *I. H. P.* p. hr. (pist. displace.)			10.44	10 97
" " " " " (from diagram)			14 6	14 2



[6]The results of this investigation give, of course, only two points on each of the upper curves, but the lower ideal curve was determined accurately by computing the water-rates of several additional cycles working under the same conditions as regards initial and final pressures, but with varying ratios of expansion.

The outcome of this study of a typical and famous case of design of machinery for a war-vessel, is interesting in several particulars, as well as from the fact that it illustrates well the methods of utilization of the modern theory of the real, as distinguished from the ideal, steam-engine. The steam-pressure is what would to-day be termed moderate for a triple-expansion engine in ordinary service; the ratios of cylinders are adapted to a moderate ratio of expansion, a total of about 7:5 and the whole installation is obviously designed to give great concentration of power rather than extreme economy; effecting this purpose by high mean effective pressures and by high engine speed, as well as by extremely careful and skilful design of details, combining in remarkable degree lightness and all needed strength. These favorable conditions and the large size of the engines, aggregating over 9,000 *I. H. P.*, account for the good results noted, in spite of the low ratio of expansion, the moderate vacuum, and the hard-driven furnaces.

Comparing results of trial with those of computation, we find that, could the engines have been converted into the Carnot type, and all extra-thermodynamic wastes extinguished, they would have demanded 10,970 *B. T. U.* per *H. P.* per hour, and 10 lb. of feed-water or steam. Working in a purely thermodynamic cycle of the Rankine adiabatic form, these figures would become at the actual ratio of expansion about 14,000 and 13.4; while the coal demanded would have been, on the assumption above indicated, 1.4 lb. per *I. H. P.* per hour, where, actually, above two lb. were burned, making the extra thermodynamic wastes about fifty per cent.

The computed internal wastes are seen to be about 6 3-4 lb. per *I. H. P.*, raising the computed expenditure of steam to 19 lb. per *I. H. P.*, where, in the ideal case of Rankine, it was 13 lb. The computed external loss by conduction and radiation was found to be insignificant and is neglected. The final comparison, as best shown in the tabulated statement of results, shows very satisfactory correspondence between the computed and the actual results, so far as comparison is permitted, and the curves in the last diagram permit the extension of the study of this case beyond the limits of its experimental range.

It is seen, for example, that the thermodynamic performance of the engine was such as to justify the conclusion that it would give increasing economy, with increasing ratios of expansion, far beyond the limits set by the controlling demand for concentration of power, as illustrated on the trial of the machine, and, in fact, beyond the limits of our diagram, if financial considerations are not brought into the case. The limits set by its own extra-thermodynamic wastes are evidently far beyond those fixed by the special conditions controlling the design of the machinery of a war-vessel.

This case is but one of many illustrating the fact that the engineer, in attempting to design steam machinery —or any other, in fact—for any stated place and purpose, is compelled to study the ultimate aim and purpose, and to adapt his design to its required work by a system of compromises between all the various claims included in the definition, for that particular case, of the term "efficiency."

PAINTS AND VARNISHES USED FOR THE PRESERVATION OF METALLIC SURFACES—III.*

BY PROF. A. H. SABIN.

A still further step consists in the substitution by the makers of driers of rosin or rosin oil for linseed oil. These are found to combine with the lead and manganese oxides even more readily than linseed oil does, and they cost only from a tenth to a fifth as much. Driers made with rosin and benzine are much less expensive than oil. The temptation is to add them in excessive quantity, and this is not uncommonly done. Such a practice is highly injurious, partly because oil thus diluted makes a thinner and less substantial film, partly because an excessive amount of drier makes the film less durable and partly because it is generally agreed by experts that rosin is an injurious addition to oil.

From a consideration of the foregoing it will appear that, while raw oil is a definite substance, boiled oil is a name applied to a large variety of manufactured products. It is also possible to make boiled oil from fish oil or other cheap oils, and these are not infrequently used to adulterate boiled linseed oil. Heavy mineral oil, such as may be purchased at one-fourth to one-half the price of linseed oil, is also used in this way. These latter practices of systematic adulteration are especially followed by the manufacturers of paints. They take the ground that the users of paint ought to pay a fair and legitimate price for linseed oil paints, and that if they prefer to purchase at a lower price it is the business of the paint manufacturer to make, at a reasonable profit, a paint which meets their requirements. It requires a tedious and expensive chemical analysis to detect these adulterations in mixed paint, and those who try to economize by buying paint below its market value are not likely to resort to such means.

The oil, variously compounded or mixed with these driers and solvents, is mixed with the finely-powdered pigment in a mixer, which is usually a cylindrical vessel provided with a revolving stirrer. The pigment has previously been ground dry to such a degree of fineness that most of it will pass through a sieve having a mesh of 100 to 200 to the linear inch. Usually it is not actually bolted, but that is about the degree of fineness which is desirable. The sharper and harder substances should be the more finely powdered. It is common to put the paint thus mixed on the market in this condition as it comes from the mixer, but the more approved practice is to take it from the mixer to a burr-stone mill and to grind the paint through the mill, thus securing a more intimate mixture and breaking up all little lumps. This grinding adds materially to the cost of the paint, and it is probably not commonly done with cheap paints intended for structural metal, since it is impracticable for an expert to take a well-mixed sample of paint and to declare, under oath, that it has not been ground.

What is meant commercially by a pure raw oil paint is made by mixing or grinding a pigment in pure raw linseed oil to which has been added enough drier to make it dry hard enough to handle in twenty-four hours, and containing enough turpentine to amount to from 5 to

* From a paper read before the Boston Society of Civil Engineers, and contained in the Journal of the Association of Engineering Societies, U. S. A.

15 per cent. of the oil. This turpentine is added in order to make the paint work more freely under the brush, and also because it is the belief of the paintmaker that it is impracticable to otherwise add as much pigment to the given amount of oil as is necessary for the greatest durability of the product. It is by diluting the oil and lessening its amount in the film that turpentine acts as a drier. It does not itself promote to any great degree the oxidation of the oil, but by lessening the amount of oil it correspondingly lessens the need of metallic oxide driers. Turpentine is added for technical purposes, not for economy, and it is often more expensive than oil. On the other hand, the use of benzine is always dictated by a desire to save money. In other respects it is objectionable. Kerosene has also been very widely used as a substitute for turpentine, but does not enter into any first-class products.

Varnishes.—Linseed oil is also used in the manufacture of varnishes, which are used as protective coatings, either alone or mixed with pigments. The other ingredients of varnishes are various resins, which give hardness and luster, and turpentine, which again acts as a solvent and is not in any considerable degree a part of the final permanent film, though it does oxidize somewhat, and doubtless a small part of it remains behind while the major portion evaporates.

The varnish resins are of vegetable origin, having exuded, as spruce gum does, from the trunks of trees; and in some few cases these lumps of resin are detached from the living tree and sold for use. Such are called "recent" resins, and the most common one is what is called "manila," and comes from the East Indies. More often the resins are not suitable for the varnishmaker until they have acquired considerable age. The tree to which the lumps of resin are attached died and fell to the ground and decayed; the resin became gradually buried in the earth; its volatile part escaped; it became hard and brittle. In this state it is found by the natives, who dig it up and sell it to the local trader, and it becomes an article of merchandise. Such are called "fossil resins;" they are of many sorts, and are found at many places, especially in the tropics. Africa, South America and especially New Zealand are great sources of supply.

The varnish resins are commercially spoken of as gums, but differ from true gums, such as gum arabic, in being insoluble in water. These pieces of resin are carefully cleaned, by scraping and otherwise, and sorted; the paler sorts are more valuable than the darker; not because they are otherwise better, but because they are less common, and people value pale varnishes more than equally good dark ones. The varnish-maker puts a quantity of this resin, usually 100 pounds, in a flat-bottomed copper kettle capable of holding about 150 gallons, which is mounted on a little iron truck, and this kettle is placed over a hot coke fire. In about half an hour the resin has melted, the temperature being from 600° to 900° F., and is found to have lost from 20 to 25 per cent. of its weight, which has gone off as a vapor. In reality, the resin has become decomposed by the intense heat, and what remains in the kettle is one of the products of this decomposition. Immediately the varnish-maker takes the kettle from the fire and adds to it some hot linseed oil, the quantity varying from about 30 pounds to sometimes as much as 300 pounds. The oil having been slowly added and well stirred in, the kettle is returned to the fire, and its contents are cooked together until combination is effected.

If it is desired to produce a hard varnish, with a very brilliant surface, a comparatively small amount of oil is used; but if the varnish is to be highly elastic and durable a large proportion of oil is necessary. Since one of the most essential qualities of a varnish for any ordinary use is a high degree of luster, while durability is of less account, because most varnishes wear off by use of the articles to which they are attached, it will be plain that for the preservation of structural metal work against corrosion an entirely different kind of varnish from those in ordinary use is required.

When the resinous matter and the oil are properly combined, which may take many hours, the kettle is removed from the fire and allowed to cool somewhat, and the contents are then diluted by the addition of an amount, previously found to be suitable, of spirit of turpentine, so that when cold the varnish will flow properly under the brush. Varnish is much more viscid than oil, and it is therefore possible to apply it in a thicker film. It is much harder than oil, and therefore resists abrasion; and it is much less porous than oil. It therefore naturally has by itself in some degree the qualities which we aim to give to oil by the introduction of pigments; and if it be so made and proportioned that it does not contain in itself the elements of dissociation, there can be no question that is is more valuable than an oil paint. As a matter of fact, it has for generations been used over paint to protect it from the weather, and no fact is better established than the permanence of a well-made varnish.

The question naturally arises, why may we not still further increase this permanence, as we do in the case of an oil film, by the addition of a pigment? If the latter works so well with oil, why may it not with varnish? The fact is that pigments do increase the durability of varnishes for the same reasons and in the same degree that they benefit oil films, and by far the most permanent paints which it is possible to make are made in this way. These will not, of course, be as brilliant and lustrous as the varnishes alone, the pigment having an opposite effect, but will be far more so than an oil paint, and will be smoother and harder; while if properly made, they will remain sufficiently elastic.

Varnishes are sometimes observed to crack and to come off bodily, instead of wearing off from the surface. This is the worst fault a varnish can have, and is due to its being made of unsuitable materials or in an unskillful way. Any considerable amount of common rosin in a varnish will cause this, and it may also be due to other causes. A good varnish, used for the purpose for which it was designed, will not do it. The commonest adulterant of varnish is rosin, which may itself be made into a varnish and mixed in any proportion. A well-made rosin varnish has a very brilliant surface, and works fairly well under the brush, but a comparatively small amount of rosin will simply destroy the durability of the best varnish.

The objection to the use of varnish paints is their cost. From the nature of things, varnish is much more expensive than oil. When one puts so valuable a material as a good varnish into a paint he naturally will

insist on putting it through a mill, and when we compare the cost of it with that of an oil paint run through a mixer there will be a striking difference. Suppose it costs twice as much. This would probably be a minimum. The minimum cost of applying any paint will be as much as the price of the oil paint. Then, when the two are applied, they have cost in the proportion of two to three. If the varnish paint will last fifty per cent. longer than the oil paint, it will then be as economical. It is the opinion of the writer that it has been proved by actual use to be more than 100, and in many cases 300, per cent. more lasting.

Varnishes are also made which contain asphaltum, which is a mineral resin, instead of the vegetable resins already described. These are, of course, black, and they may be made with part vegetable resins and part asphaltum if so desired. The objection to asphaltum is that when used with any considerable proportion of linseed oil its remarkable non-drying qualities make it difficult of use. Its advantage is its cheapness and also its wonderful permanence. When properly combined, however, it is a most valuable material. The simplest way to overcome its effect of preventing the oxidation of oil is to subject the varnished object to the action of hot air. The activity of the oxygen is thus enormously increased, and oxidation proceeds in spite of all obstacles. This is the process known as japanning or enameling, and it has the further advantage that the adhesion of the coating to the metal is much increased, while at the same time the porosity of the coating is reduced almost to nothing. This is because the coating material is kept in a melted or semi-fluid condition while the oxidation is going on, and the pores are destroyed or closed by the flowing of the material itself.

The way this is done is by coating the object, usually by dipping it in the varnish. Then it is put in an oven and baked at a temperature of from 200° to 400° F. for several hours. Sometimes several coats are thus applied in succession. Varnish paints are sometimes applied in this way, making colored enamels of great beauty and durability. But it is possible to use asphaltum in varnishes which will dry at ordinary temperatures. This is most commonly done by using very little oil; also by a large amount of drier, but better by mixing a varnish of asphaltum with one made of other resins. It is also possible to make a varnish containing a considerable amount of asphaltum which will dry reasonably well by great care and skill in its fabrication. It may safely be said that asphaltum is one of the most difficult substances to use, that while excellent results are obtainable, they are more difficult to obtain than with any other substance, and that bad results are very common.

In conclusion, it remains to be observed that while nothing is here said of the importance of methods to be employed in cleaning the metallic surface, this is not because it is a matter of minor importance. On the contrary, it is of so great importance that a separate discussion of its value and the means of doing it would be necessary, and this paper is therefore confined to an account of the materials used. The comparative value of these is difficult to determine, and varies in different cases; but in general the writer has been led to the conclusion that there is not a very decided difference between different pigments in their value for the prevention of corrosion; that varnishes and varnish paints, when made with proper knowledge and skill, are better than oil paints; that these latter give probably better average results than red lead, but that, when the best possible results of red lead are attained, it is considerably better for most exposures than oil paints, and that the use of adulterated materials, either through ignorance or design, is a most serious and common evil. This is rather the fault of the purchaser than of the maker. If the former would not buy, the latter would not make the inferior article.

STEEL FREIGHTERS PLEIADES AND HYADES, FOR THE BOSTON TOWBOAT COMPANY.

Among the vessels recently turned out at the Atlantic coast yards, none possesses more interest, for those who hope for the return of the supremacy of the American merchant marine, than the two steel steamers for the Boston Towboat Company, built at the Sparrow's Point yard of the Maryland Steel Company. These vessels, the S. S. *Pleiades* and the S. S. *Hyades,* are of a type on which will depend largely the future of the American merchant marine—the ocean freighter. This type of vessel, unfortunately, has not been hitherto of frequent occurrence in the American registry. The new vessels are distinctively cargo-carriers, and are similar to the better class of "tramp" steamers now so numerous under flags other than our own. They are designed to carry freight in bulk, such as coal, grain, rails, etc.

The dimensions of the vessels are: Length over all, 350 ft.; length between perpendiculars, 330 ft. 6 in.; beam moulded, 47 ft.; depth at side moulded, 28 ft.; sheer forward, 8 ft.; aft, 3 ft. The gross tonnage is approximately 4,000 tons.

As they are from the same designs, the description of one will apply to both.

Steel castings have been used to a considerable extent in the construction, the lower part of the stem, the stern frame, rudder frame, and extension stock being of this material. The upper part of the stem is a steel forging.

The hull is built to the highest requirements of the United States Standard Register of Shipping for twenty years rating. There are seven full bulkheads extending the entire width of the ship, six of them water-tight, and extending to the upper deck. There are two steel decks extending all fore and aft, 1-2 in. thick; a poop deck 50 ft. long, a bridge deck 80 ft. long, and a forecastle deck 50 ft. long, all of steel, 3-8 in. thick.

The water bottom is 40 in. deep, and extends from the collision bulkhead forward, to the stern tube bulkhead aft, affording capacity for a water ballast of 750 tons, in addition to 353 tons in the forward and after peak tanks.

The tanks are operated by means of a horizontal duplex ballast pump having steam cylinders 7 1-2 in. dia., and water cylinders 10 1-4 in. dia. by 10 in. stroke.

The sea valves are arranged so that the tanks are filled through the pipes by which the ballast pump empties them. These pipes are 5 in. dia., and as the tanks extend clear across the ship provision has been made for drawing the water from either side of the tanks, so that the

vessel may be pumped out completely, even when listed far to one side.

The engine room tank does not extend across the ship, the centre keelson being water-tight in this compartment, pipes leading from the ballast pump to each of the two tanks. The after frame space under the engine room is made water-tight, and used to receive its drainage, one of the main bilge pumps being used to free this tank of water.

The vessel has seven cargo hatches, the largest 20 ft. square, and the smallest, 20 ft. by 14 ft. On the lower deck they are increased to 26 ft. in width. The covers for the upper deck hatches are of steel, and for the lower deck hatches, of wood. On the lower deck numerous plates have been made portable to assist in trimming coal.

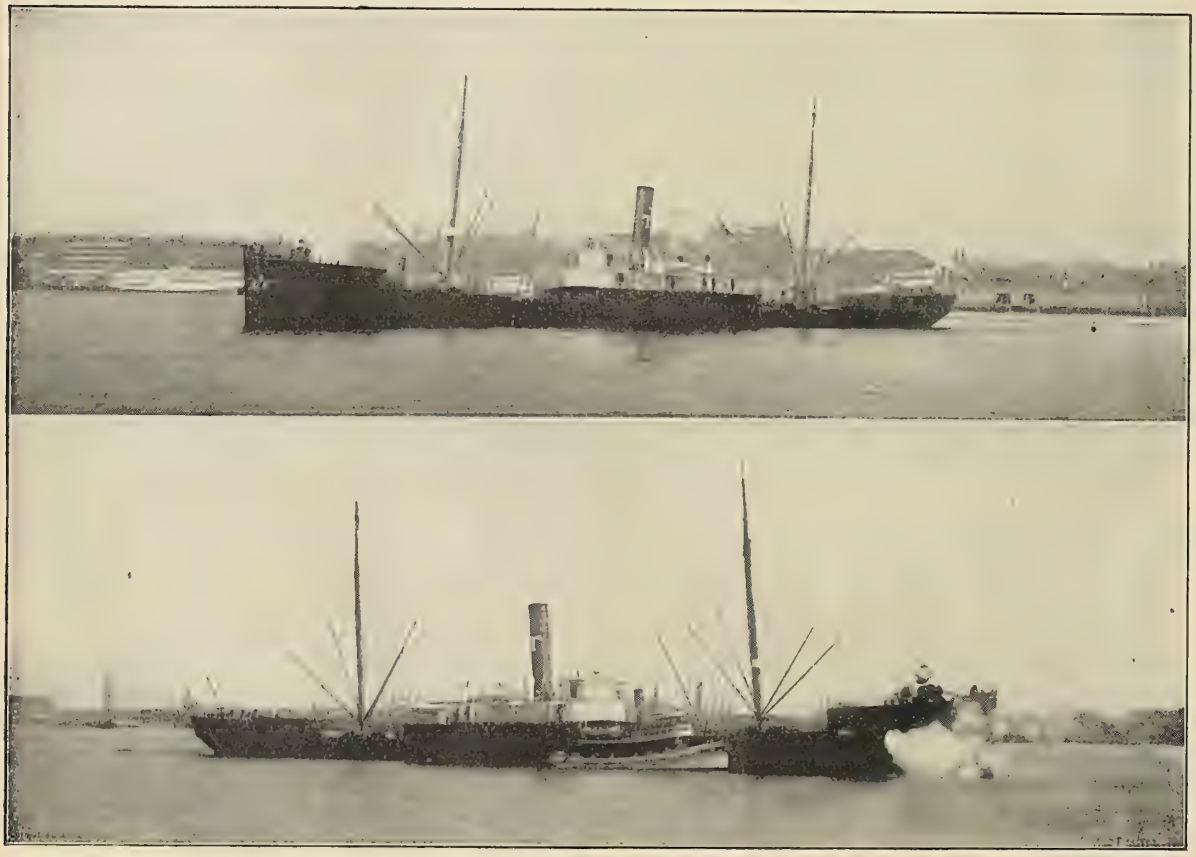
The ship has a complete outfit of deck machinery of the latest type. The windlass is for 2 1-8 in. chain, and was manufactured by the Hyde Windlass Co. The four deck hoisters are Williamson's double drum, double cylinder, 8 in. by 8 in., spur geared type. The capstan aft is a No. 3 Hyde, with cylinders 6 in. by 8 in.

The steering engine, 7 by 7 Williamson, is located in the after end of the engine room on the main deck, the steering ropes leading along on top of the upper deck to the quadrant, under the poop deck. A Robinson No. 9 hand steerer, made by the Bath Iron Works is connected to the extension stock on the poop deck.

There are two 20 ft. metallic life-boats, carried on bridges alongside the house, and an 18 ft. dinghy stands on the bridge deck.

The masts are of steel, with wooden topmasts, rigged as a fore and aft schooner, with leg-of-mutton sails. Each mast has four cargo booms, stepped in cast steel sockets, riveted to the masts. In addition to these are two booms, stepped in sockets on the main deck, between the second and third hatches.

The quarters for officers are arranged in a house on the bridge deck. The Captain has a large room on the starboard side, with a private bath, and ample saloon. The galley extends across the house, between the boiler casing and engine skylight. On the starboard side are officers' staterooms and engineers' state and mess-rooms; on the port side the Captain's pantry, officers' mess-room and toilet, and two spare rooms.

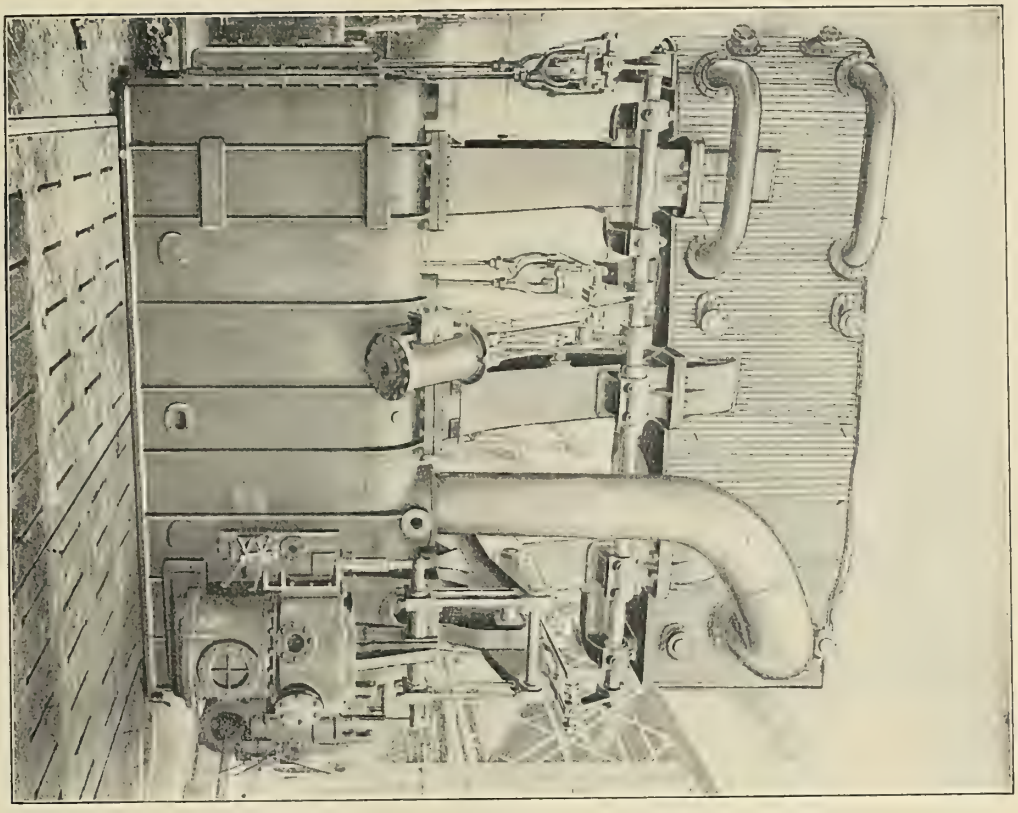


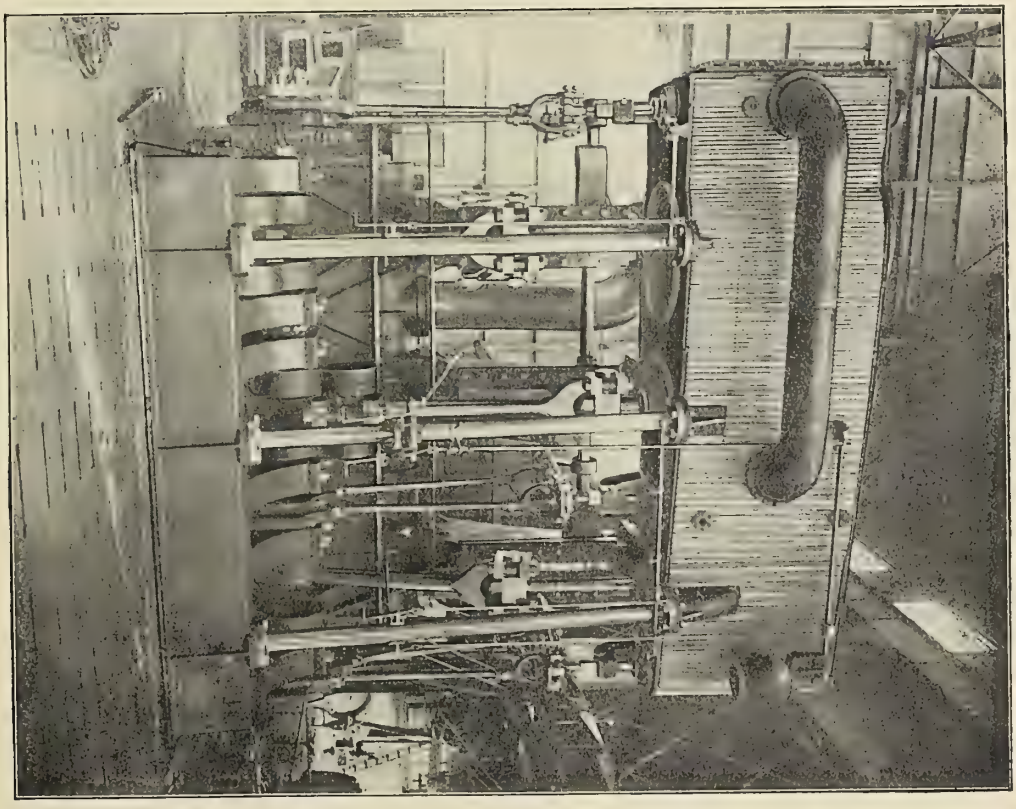
VIEWS OF THE BOSTON TOWBOAT COMPANY'S STEEL FREIGHTER HYADES.

The deck house is surmounted by a steel pilot house and chart room, with a private stairway from the Captain's room. A bridge is carried from the side of the house to the side of the ship, with a flying bridge directly above.

The crew's quarters are under the forecastle deck. The entire crew, including officers, will number about thirty.

The engine cylinders are 21 in., 35 in. and 56 in. dia. respectively, by 42 in. stroke, arranged with the H. P. forward, and the L. P. aft. The horse power is about 1,600 on 90 revolutions per minute. The H. P. and I. P. cylinders are fitted with piston valves, and the L. P. cylinder with a double ported slide valve, and a counter balance cylinder for taking the weight of the valve off the valve gear. The latter is of the ordinary Stephenson





FRONT AND BACK VIEWS OF THE MAIN ENGINE OF THE STEEL FREIGHTER HYADES.

type, with double bar forged links. The H. P. cylinder is fitted with a cast iron liner, which is held in place by gun metal tap bolts.

The crank shaft is of the built-up type, 12 in. dia. in the journals and pins, of forged mild steel throughout. The connecting rods, piston rods and crossheads are of forged steel.

The excellence of the steel castings available at the present day has made it possible to use this material for certain parts of the engine, and thus avoid some of the expensive forgings formerly necessary; among these being the forked ends of the eccentric rods, and the reversing arms.

As shown in the cuts, the engine is of the open front type, having steel front columns and slipper slides on the crossheads, working in guides bolted on the back columns, the latter being built on top of the condenser.

The condenser contains 2,587 sq. ft. of cooling surface, the tubes being 3-4 in. outside dia. and 15 ft. long, of brass. The reversing engine is placed on top of the condenser, where it is easily accessible for overhauling, and works to good advantage. It is 12 in. dia. by 20 in. stroke, and is supplied with steam at boiler pressure.

The air pump is bolted to the back of the condenser, and worked off the low pressure crosshead. It is 24 in. dia. by 13 in. stroke, and has one bilge pump on its forward side, and one on the after side.

The main exhaust pipe is of copper, 19 in. dia. The main steam pipe is of copper, 8 in. dia., and leads to a cast iron throttle valve, of the ordinary double beat type, with compound lever connections. The handling gear for the throttle valve and reverse engine is attached to the middle front column, and worked from the lower platform. The cylinder drain cocks are worked by levers under their respective cylinders. The by pass valves are worked by rods leading to them from the lower platform fitted with hand wheels, directly over the throttle and reverse gears.

A worm and worm wheel are fitted at the after end of the engine for turning it over by hand when setting valves, or making repairs.

The thrust block is set up on a continuation of the steel foundation under the engine, but is not bolted directly to the engine bed plate. It affords a bearing surface of about 685 sq. in., which reduces the pressure due to the thrust of the propeller to about 45 lb. per sq. in. The main engine and the thrust and line bearings are fitted for ample water circulation. The thrust shaft is 12 in. dia., and has six collars, 19 in. dia. The line shafting is 11 3-4 in. dia., and the propeller shaft is 12 1-4 in. dia., all of forged steel.

The propeller wheel is of the sectional type of cast iron, with four blades, 14 ft. 9 in. dia., by 13 ft. 9 in. pitch at the tips, and 13 ft. 3 in. at the root of the blades. The developed surface is about 75 sq. ft.

The two Scotch boilers fitted are 14 ft. 6 in. dia., by 10 ft. 9 in. long, inside of the heads, and are built for 175 lb. steam pressure. Each boiler contains three corrugated furnaces of the Purves type 45 in. dia., 19-32 in. thick. The tubes are 3 1-4 in. dia. by 7 ft. 7 in. long. The total heating surface for the two boilers is 4,400 sq. ft., and the grate surface 146 sq. ft., making a ratio of heating surface to grate surface of 30.

Each furnace has a separate combustion chamber, the backs of which are slightly inclined to give as free liberating surface as possible for the steam.

The axes of the boilers are placed fore and aft, and the fire room is 10 ft. wide in that direction.

The smokestack is high, its top being 71 ft. above the grates, which, however, is not excessive for natural draft installations.

The coal bunkers are forward, and at the sides of the fire room, with a capacity for 625 tons of coal, which is sufficient for a transatlantic voyage.

The athwartship bunker is recessed in the middle of its length for an ash ejector hopper, which sends the ashes overboard on the starboard side. One of the two 30 in. ventilators in the fire room is arranged to be used as a passage-way for ash buckets in case the ash ejector is being overhauled, and a steam hoister is bolted to the forward bulkhead of the fire room for the purpose of handling the buckets.

An electric lighting plant, furnished by the B. F. Sturtevant Co., consisting of a 10 K. W. generator and an upright 7 in. by 7 in. engine, supplies current to 80 incandescent lights and to a 3,000 C. P. searchlight.

These steamers are intended to make 10 knots speed, when loaded to 22 ft. draft, at which draft they will carry 5,500 gross tons dead weight. The immersed midship section area is 1,010 sq. ft. at the above draft, the wetted surface 24,600 sq. ft., and the tons per inch immersion, 33 1-2. The cargo capacity, including bridge house and poop, is 259,600 cu. ft., or 5,750 tons, at 45 cu. ft. per ton. The vessels are fitted with tanks holding 6,000 gals. of fresh water.

The design and construction of the two boats has been conducted under the personal supervision of C. W. Wiley, superintending engineer for the Boston Towboat Company.

Loss of S. S. Mexican.—Probably the most serious disaster in connection with the transport service between the mother country and the seat of war in South Africa, was the loss of the Union-Castle liner *Mexican*, which was run down by the transport *Winkfield*, but fortunately remained afloat long enough to effect a transfer of passengers from the liner to the transport. The *Mexican* left Cape Town on a homeward trip April 4, and soon after ran into a fog bank. She was slowed to half speed, and when about 80 miles out she was rammed amidships by the *Winkfield*, bound to Cape Town with troops and horses. The *Winkfield* was badly damaged, but was in no danger of foundering, and to her the 200 odd passengers and crew of the *Mexican* were transferred in the boats, together with most of the mails and valuables. The *Winkfield* then proceeded to Cape Town and reported. Another transport was immediately dispatched to find the *Mexican*, but that vessel had apparently gone down, for no trace of her was to be seen.

Prize Money.—The U. S. Court of Claims has awarded Rear Admiral Sampson $8,375 as his share (one-twentieth) of prize money for the destruction of the Spanish vessels at Santiago. The further sum of $158,365 is to be apportioned among the U. S. naval officers and men of the ships which participated in the battle.

SCHOOLS OF MARINE ENGINEERING AND NAVAL ARCHITECTURE.

An Account of the Courses and Conditions at Glasgow University, Written by An American Student.

BY GEORGE CROUSE COOK.

The University of Glasgow was founded by authority of Pope Nicholas V in a bull issued during the year 1450-1. This bull also granted the University power to confer such degrees as were then in vogue and established certain laws and regulations. In subsequent years, through the energy and zeal of its leaders, the University won a permanent and growing patronage. Its original three faculties have been gradually increased to five at the present time, viz., Arts, Science, Medicine, Law and Theology, engaging the services of thirty-one professors.

DISTANT VIEW OF MAIN BUILDING, GLASGOW UNIVERSITY.

The character of that portion of Glasgow in which the University was established at its foundation became so changed in the later growth of the city, that early in the present century the question of removal to a more desirable section was discussed. After several unsuccessful attempts had been made to secure a change of location sufficient money was obtained by private subscriptions and State aid, in the year 1864, to purchase a valuable site in the northwestern part of the city, and there erect suitable buildings for the educational necessities of the time. In addition to the new buildings, a three-story portion of the old college, which bears the date of 1658, was taken down, removed to the new site, and there re-erected with slight modifications as a gate-lodge at the northeastern entrance to the University grounds.

Within limitations prescribed by the State, the University is governed by two bodies. The first is the Senatus Academicus, which is composed of the principal and the whole of the professors, and which has charge of the instruction and discipline of the students, the awardment of degrees and which determines the exemption from any part of the University course or examinations of a candidate for a degree who presents certificates from other schools. The second body is the University Court, which is composed of the principal, representatives of the Glasgow City Council, the University faculties, the graduates and students. It forms a court of appeal from the Senatus in certain cases and administers the funds and property of the University.

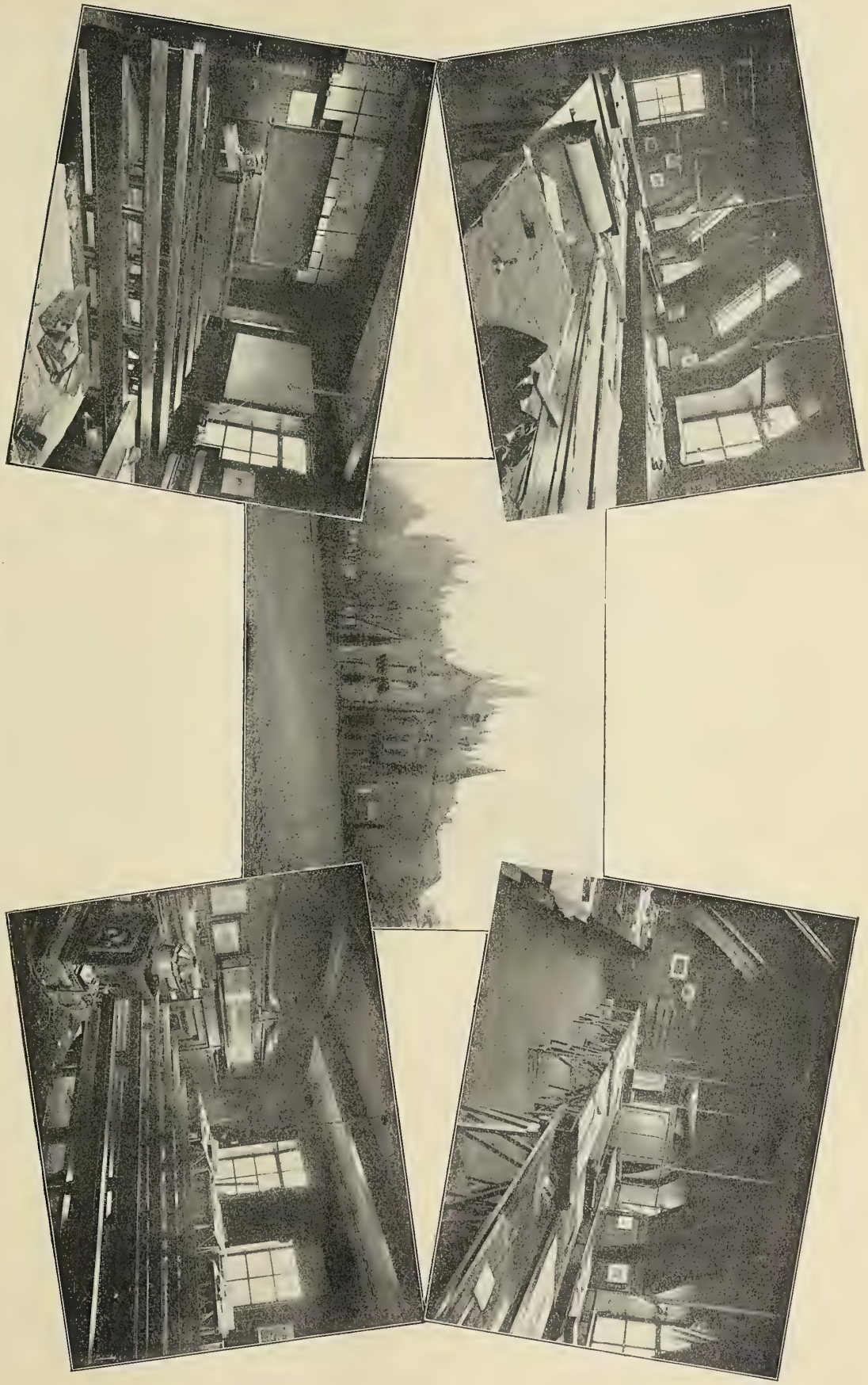
The modern development of the Faculty of Arts was materially advanced when, in 1883, the widow of John

Elder, who was the head of what is now the Fairfield Shipbuilding Co., of Glasgow, endowed the University with the sum of $60,000 for the support of a chair to be known as the John Elder Chair of Naval Architecture. This chair was later connected with the Faculty of Science on its foundation in 1893. As no satisfactory space in the main building was available for this work, the two upper stories of the previously mentioned Gate Lodge were fitted up as drafting, lecture, and professor's rooms. The entire upper floor is used as the drafting room. This is heated by two open fireplaces and lighted by side and overhead windows and gas. Fixed drawing boards, with drawers, are built about three sides of the room, while along the central part stand a number of portable tables. The tables are supplied with battens, weights, three good planimeters, a convenient calculating machine and two excellent integrators. A relic of the racing yacht *Valkyrie,* some working models, and a few framed photographs hang upon the wall and complete the equipment of the room. The second floor, of the same dimensions as the upper, is divided by a bulkhead into a lecture room and professor's office. The lecture room is heated by a single fireplace, and is fitted with raised platform and desk for the lecturer; back of this desk on the division bulkhead is a slate blackboard, while on one side rests a stereopticon for illustrating lectures, with the associated screen on the opposite wall. Half a dozen rows of narrow wooden benches, with narrower desks for the students, are arranged in front of the platform. Apparatus for demonstrations and for the illustration of lectures stands about the room, and models of different types and varying degrees of completeness and condition hang upon the walls.

The course of this chair is designed to be taken as a portion of the regular curriculum leading to the degree of B. Sc., and extends over three sessions. During the first session, in association with other regular work, a junior course in ship and engine drafting is taken, which requires at least nine hours per week attendance in the drawing room; this time is usually made up on three days from 2 until 5 o'clock. In the second session a junior course of lectures in naval architecture and marine engineering is attended, and a senior course in drafting; the senior lectures are given daily, except Saturday, from noon to 1 o'clock, while the drafting is arranged as in the junior course. The third session consists of the senior course of lectures, which are given daily, except Saturdays, from 11 to 12 o'clock. In both junior and senior series of lectures a lecture on an average of once a week is given on the subject of marine engineering.

The junior course in drafting takes up the following work: Laying off and fairing a vessel from offsetts; calculation from these lines, of displacement, centers of buoyancy, areas and centers of gravity of water planes, tons per inch, moment to change trim, transverse and longitudinal metacenter and coefficients of form; drawing sections for cargo space, plotting cargo curves, distribution, and center of gravity of cargo vertically; calculations of curve of metacenters and the metacentric height under various densities of cargo; calculations for change of trim with bilged compartments; curves showing percentage of length, which may be safely flooded; launching calculations, with curves; strength, calculation of distribution of hull weights, curves of supporting forces in various forms of waves considering the various pressures due to depth, curves of load, shearing forces and bending moments; the ship's section at point of maximum stress and calculations of its inertia and effect of the bending moment; distribution of shearing stress at point of maximum shear; drawing sections by various rules and, if the time permits, designing a marine boiler. The senior course of drafting includes: Designing a vessel to fulfill given conditions of speed, weight, carrying power, etc.; general arrangement plans and corresponding structural plans; stability calculations under different conditions and cross curves of stability; calculations upon the results of trial trips. The design taken up by students may be a battleship, cruiser, torpedo boat, cargo or passenger steamer, and sail or steam yacht, and if there be sufficient time the principal parts of a steam engine.

The junior series of lectures embody the following topics: Ship calculations, including displacement, center of buoyancy, metacenter, change of trim, experimental determination of center of gravity of a ship, effect upon trim and stability due to flooding compartments, also due to filling part or whole of holds with cargoes of varying density, lifting and tipping efforts in launching, and tonnage; strength of ships, including general consideration of strength of a girder, application to a ship in still water, elements of trochoidal wave theory and its application to finding supporting forces in a ship on a wave, determination of distribution of weight in a ship and the resultant effect upon her structure when in still and wave water, both in upright and inclined positions; consideration of effect of heave of sea upon supporting forces and weights; transverse strength of ship, strength of various details of construction, including butt fastenings. The senior series comprises: Stability of ships, including the mathematical investigation of the fundamental formulæ of stability calculations, consideration of the surface of buoyancy and flotation, metacenter curves, curves of statical and dynamical stability, cross curves of stability, elementary considerations of oscillation of a ship in still water and among waves; resistance and propulsion of ships, including consideration of the earlier theories and experiments of Froude upon models; relation of resistance of ship and model, law of comparison, progressive trials of ships, relation of effective to indicated horse power, effect of waves upon speed of ship, theoretical efficiency of various kinds of propellers, determination of best diameter of propeller for a ship, ship design, including determination of dimensions of ship to fulfill given conditions, method of determining form of ship, estimates of weight of hull and outfit, weight of machinery in relation to power and type, approximate methods of determining elements of design for preliminary consideration, factors of strength for various types of ships, consideration of points of importance in special classes of vessels. The engineering lectures for Seniors and Juniors cover: Marine Engine and Boiler Design, including determination of sizes of cylinders, valves, shafting, pumps, propellers, boilers, furnaces, funnels, steam pipes, etc., with the theoretical and practical considerations governing marine practice.



GATE LODGE AND INTERIOR OF RECITATION AND LECTURE ROOMS IN NAVAL ARCHITECTURE.

In the drawing room, the instruction is under the immediate direction of the assistant professor, who lays out the work for each student and daily inspects its progress and character, giving such direction and assistance as may be required; the professor makes an ocsional visit, criticising and suggesting. The naval architecture lectures are given in the lecture room by the professor, who occupies the platform, and board and lantern are frequently put into use in demonstration and illustration. While there is a definite line which the lectures follow, there are frequent, interesting, impromptu discussions by the professor, which are taken from his store of practical experience. In the occasional absence of the professor, the platform is occupied by his assistant, who also delivers the lectures on Marine Engineering.

The complete course as outlined in the foregoing is, as already stated, the one taken by students entered for the degree B. Sc. and is, of course, the most satisfactory. There are several modifications of this which are taken by men having no interest in the general degree work, or with limited time or means to devote to study. A very satisfactory one of these, and the one taken by a great number of American students, extends over a single session and consists of the Junior and Senior lectures together with the Senior Drafting. It is obvious that a student to get the full benefit of this time must have a good foundation in the elementary principles of naval architecture and a good working knowledge of mathematics including the first principles of the integral calculus. For this special course, no preliminary examinations or qualifications are required, and on completion, all lectures, examinations, and classes having been attended satisfactorily, a certificate is given of proficiency in naval architecture. This session extends from October 20 to March 27, with a vacation of two weeks at Christmas. Holidays can be most satisfactorily employed in visiting neighboring shipyards, where students are generally admitted. A second excellent course which calls for an attendance during two sessions and results in a "Certificate of Proficiency in Engineering Science" consists of the following work: The four classes in naval architecture and one session in each of the following classes: mathematics, including integral and differential calculus, natural philosophy, chemistry and engineering with laboratory practice. This last, under the widely known experimentalist, Dr. A. Barr, deals with the strength and elasticity of materials, or it might be put as the stress and strain on materials in structures and machines, and hydraulics which investigates the principles of the flow of water and its action as a motive power. This course requires no preliminary examination and a student with previous training may be excused from attendance on certain of the classes, but must pass the final examinations at the University. During the intermediate summer vacation, a good draftsman can usually find work in a Clyde shipyard office, where the wages run from $10 to $14 a week, and an inexperienced man could get apprentice work in a yard.

Professor J. Harvard Biles, who now occupies the Chair of Naval Architecture, received his early technical education in the Government Dockyard at Portsmouth, England, and later attended the Royal Naval College at Greenwich, from which he graduated in 1875. He was then appointed an assistant naval constructor in the British Navy, and was assigned to duty at the Pembroke Dockyard, later being ordered to the Admiralty in London. In 1880 he resigned from the naval service to accept a position as naval architect at the well-known Clydebank Yard. Probably the best-known ships turned out during his connection with the yard were the *Paris* and *New York*, now of the American Line. In 1880 Mr. Biles left Clydebank for Southampton, where he acted as general manager for a new yard, and from there he passed to the Glasgow University. In taking up this educational work Professor Biles has not relinquished outside professional practice, but maintains an office as a consulting naval architect, and as such has been connected with the construction of many modern merchant and naval vessels.

Assistant Professor H. C. Sadler is a graduate of Glasgow University, having obtained the degree of B. Sc. in 1893. After leaving college he entered the shipyard of A. and J. Inglis, Glasgow, as a premium apprentice, and upon the expiration of his five-year term was appointed a calculating draftsman for the firm. From this position he was appointed to the assistant professorship in the University. He is an associate of Professor Biles in the latter's outside professional interests.

With many students the question of expense is of considerable importance. The total expense for a person starting with outfit for six months, from New York City, and taking the one session course with three classes already outlined can be brought, barring accidents, within $375. Itemized it will stand as follows: A return passage from New York to Liverpool or even Glasgow itself, on an intermediate class steamship, can be had for $90. The University fees sum at $50, for matriculation or enrolment as a student a fee of $5, and for each of the three classes attended, $15. The cost of necessary books, drawing paper, pencils, etc., is covered by the sum of $10. The expenses of living are practically within control. As there are no accommodations for students at the University, a usual, cheap, and satisfactory manner of living is that of hiring rooms with service and buying such articles of food as may be required. Service here includes care and cleaning of rooms with cooking and serving as purchased or directed. The front room of a clean, wholesome flat, in the neighborhood of the University, occupied by a mechanic and family, with gas, coal for fireplace—which is the usual method of heating employed—use of bathroom and service, can be had for $2 per week. Sufficient good healthy food can be obtained for $3 per week; these, with washing and laundry, may sum to $6; which extended over time of session, may be counted at $150. The remainder of the sum total may be justly depended upon to cancel all unconsidered necessities. The cost of the second course is, naturally, in proportion.

The clothing which is most satisfactory in the damp, rainy, moderately cold weather which prevails in and about "Glasgie cold an' dirt" during the winter season is heavy woolen underclothing and socks, a moderate weight dark suit, medium overcoat, a *waterproof* mackintosh, and heavy water-tight shoes.

PRACTICAL RESULTS OF SOME INNOVATIONS IN MODERN SHIPBUILDING.*

BY HENRY B. WORTLEY.

It may be of interest to the members of this Institution to lay before them the results of some departures from ordinary merchant shipbuilding practice, which have been embodied in eleven steamers (British built) owned by the Ocean Steamship Company and managed by Alfred Holt. These vessels, like all their predecessors in the line, are unclassed. Their moulded dimensions are 440 ft. by 52 1-2 ft. by 33 1-2 ft. They carry 8,200 tons of dead weight on a draught of 25 1-2 ft., the freeboard having been assigned by the British Corporation for the Survey and Registry of Shipping.

The profile is shown in Fig. 1, where it will be observed that the upper deck has no sheer; though for the sake of eye-sweetness, a slight sheer has been given to the bulwark rail.

The engines in normal condition indicate 3,600 horse-power, giving a continuous sea speed of 13 knots. Three of these vessels have now made two round voyages from this country to China and Japan, each covering a total distance of about 50,000 miles, and two of them have started on a similar maiden voyage of about 25,000 miles.

Amongst the innovations the following are the chief, viz.:

A. External: A rudder so hung that no stern frame has been required, and allowing the after deadwood to be cut away.

B. Internal: (1) The substitution in the main hold of two pillars in place of the usual numerous stanchions. (2) A 3-ft. frame spacing. (3) The disuse of cement on the ship's bottom inside the ballast tanks.

RUDDER, ETC.

The sterm frame of a merchant steamer is a feature which still retains to a large degree its primitive form and section. It has varied but little since its introduction into iron shipbuilding, and probably it had more arguments to justify its inception than can be claimed for its retention to-day. When introduced it was small in weight, size, and section, easy to forge, and formed a convenient method for finishing the run of a small ship. Since then the sizes of ships have gradually increased, and the stern frame has steadily advanced in weight, size, and section, until at the present time it is quite common to have stern-posts of 20 tons weight and 13 in. by 8 in. of rectangular section. It is needless to say that these posts are very clumsy to handle, even though scarphs have been introduced, and, despite the care bestowed in the manufacture, the results are not always satisfactory.

The commendable action taken by Lloyd's in the early eighties, in appointing specialists to survey forgings during the process of manufacture, and the circular issued in 1886 requiring all sections above 40 sq. in. to be welded under the steam hammer, have done much to minimize the evil; but it is not yet cured.

Cast steel was introduced for stern frames and rudders in the hope of overcoming bad welds, but a reaction has taken place against the use of this material, as many ship-owners have had unfortunate experiences of con-

*A paper read before the Institution of Naval Architects, London, England.

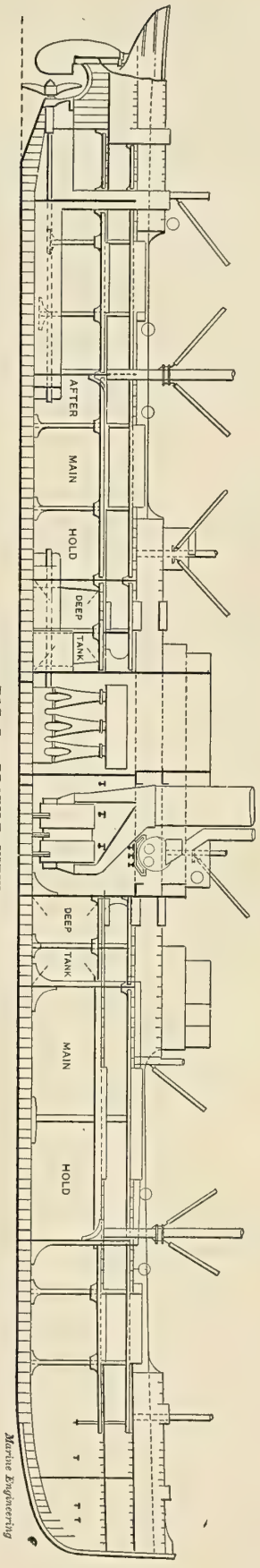


FIG 1. PROFILE VIEW.

traction flaws, necessitating the removal either of partial or complete stern frames and rudders.

The rectangular section of stern frame is most commonly used, although in some few of the largest vessels—especially twin-screw steamers—a U-shaped section of cast steel has been adopted for the inner post, while the aperture portion of the outer post has been retained of rectangular section. Now the strength of a stern frame of rectangular section is incompatible with the weight involved. Whether considered as a girder or pillar, the section is most primitive, and the number of broken stern-posts constantly seen do not justify them as being simple things to manufacture, or fitting contrivances for ending the after-body lines. When broken no other part of a ship of equal weight is so costly to repair, or requires so long a period for renewal. The form renders it incapable of being incorporated with the framing of the ship at reasonable cost, excepting at the transom, and at the upper portion of the inner or propeller post. Its whole weight is therefore sandwiched between the comparatively thin end plates of the shell, to which it is attached by a multitude of long rivets of a large diameter. The number of slack rivets observed in the after deadwood and the number of stern frames broken just below the boss clearly show that a considerable deflection takes place in thin deadwood during the ordinary working of the ship. The deadwood of the sailing ship has definite reasons to justify its existence, but it is difficult to find an excuse for deadwood in steamers. Its weight is generally greater than its buoyancy, it probably interferes with the efficiency of the propeller to an appreciable extent, and it certainly tends to prevent rapid manœuvring.

Most shipowners have experienced in greater or less degree the foregoing disadvantages of the ordinary forged or cast-steel stern frame and rudder; and many agree that the present type of stern is "found wanting." With a view to overcoming these difficulties, the following guiding principles were laid down for designing a stern and rudder for vessels of the Ocean Steamship Company's fleet: (1) That there be no useless after deadwood. (2) That a support at the heel of the rudder is not essential. (3) That forgings and castings be reduced to a minimum. (4) That the frame terminating the run of the vessel be compatible with the adjacent scantling. (5) That the frame be thoroughly incorporated with the ship's structure. (6) That the rudder be of the balanced type.

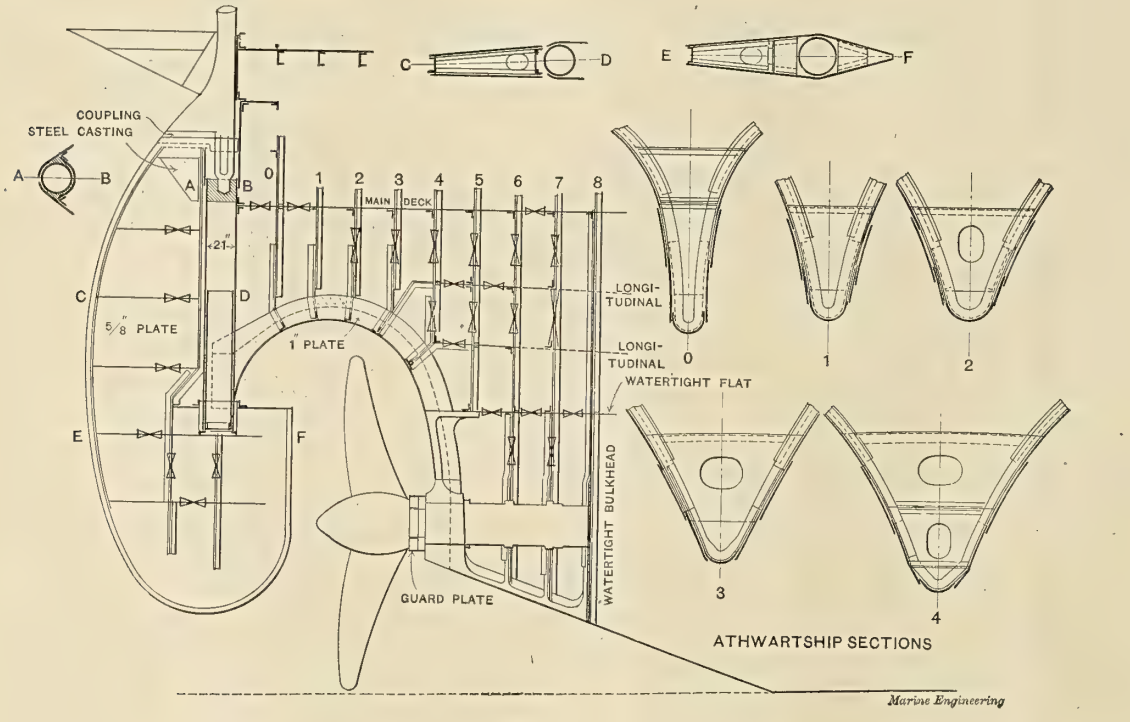


FIG. 2.

Several designs were made to meet these requirements, but the one illustrated in Fig. 2 was finally chosen. It will be noted in the diagram that the after end of the rudder is 8 in. thick, and forms the termination of the water-lines above the propeller arch. This gives a much longer and cleaner run to the vessel than is possible when the lines terminate upon the ordinary stern-post. (For comparison see Fig. 6.) The greaterst advantage however, lies in the increased thwartship width that these lines give to the stern, as it enables the requisite strength to be obtained from material of much less weight than the ordinary form of stern frame. The increased space also gives easy access to every rivet in the structure.

In this case the stern-post is made of a wrought-iron

tube 21 in. external diameter and 1 in. thick, with an internal liner at the lower part of the same thickness. The lower part of this tube forms the bottom pintle for the rudder.

The propeller arch is made of a Siemens-Martin steel plate 1 in. thick of U-shaped section. The after part of it is riveted to the sides and also the front part of the stern-post tube; and the forward part is carried down to the boss and riveted thereto. The boss is a steel casting—the size of which has been reduced as much as possible. It has one palm on the top riveted to the extension of a watertight flat, and another at the fore end of its lower part riveted to the after-peak bulkhead.

It will be noticed in the diagram that the framing of the ship is incorporated with every portion of the stern.

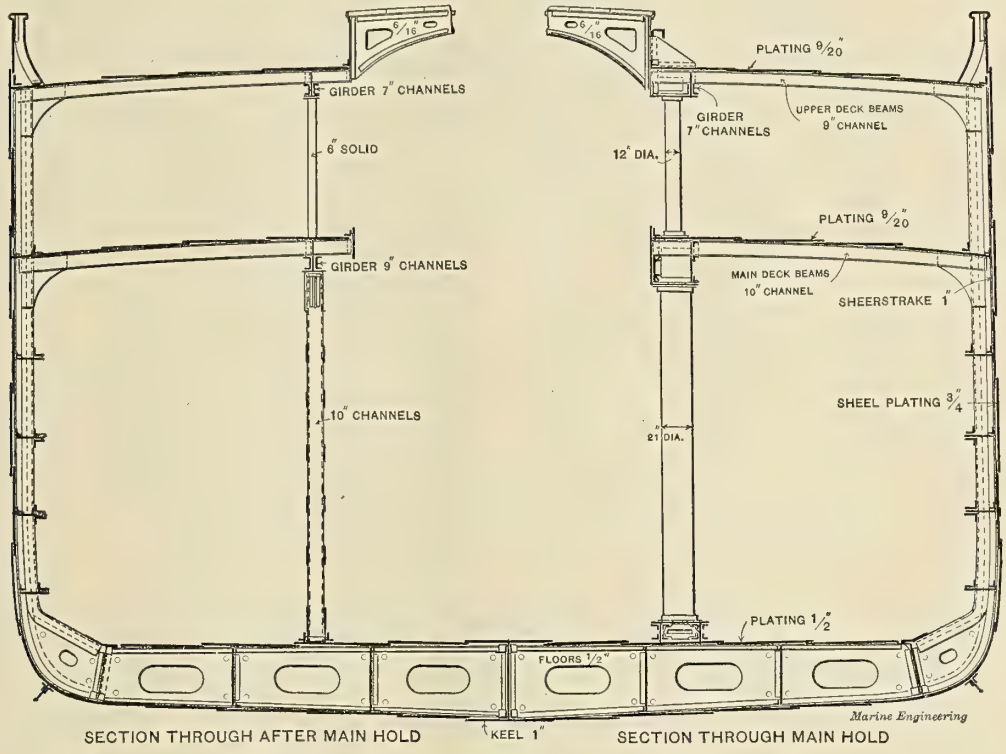


FIG. 3.

The frames above the arch plates are directly connected thereto, and two of the longitudinals are also incorporated with it. The top of the stern-post tube has an attachment to the main deck, and the bottom of it is well supported by the after sides of the arch plate. The base of the sloping part of the deadwood is formed by an extension of the keel plate. The rudder, as will be noted in the diagram, is built of plates and bars, and the interior is accessible in every part. The bow frame is of channel steel, and a flat bar at the fore side finishes the lower part of the rudder. The socket in the rudder for the lower pintle is of Siemens-Martin steel, lined with white metal working upon the lower part of the stern-post tube. At the head of the rudder is a small steel casting, with flanges forming a coupling for bolting it to the lower part of the forged-iron rudder stock, which is of ordinary form, excepting that it passes through an octagonal eye in the casting just described, and forms an additional safeguard for working the rudder in case of accident to the coupling bolts. The lower part of the forged rudder stock forms the top pintle, and is housed in a cast socket fixed into the top end of the stern-post tube, where the whole weight of the rudder is taken.

It will be observed that this form of rudder is easily made watertight, and, therefore buoyant, the effect of which is to reduce the weight on the top pintle, which takes the downward thrust. The total weight of the rudder, rudder stock, tiller, &c., is about 15 tons, and the buoyancy of the rudder at the load draught is about 5 tons, leaving a downward thrust on the top pintle of 10 tons. The total weight saved in this system of constructing the stern against the ordinary type is about 10 tons.

In the initial stages of the design the chief argument brought against the system was that it would prove to be a trap for ropes and fishing nets. To prevent a rope or fishing net plugging the water grooves in the tail-shaft bearing, a guard plate was fitted over the stern-post boss, as shown in Fig. 2; but, although these steamers have covered collectively nearly a quarter of a million miles, no such difficulty has as yet been experienced.

A trial of the manœuvring power of one of these vessels was made in the Firth of Clyde in a dead calm and slack water. The vessel's draught was 18 ft. aft and 14 ft. forward. A long run was just being completed at 4,000 indicated horse-power, which gave a

speed of 14 knots. The helm was then put hard-a-port, and the diameter of the first half of the turning circle was found to be 1,170 ft., and the second half 1,070 ft. The time occupied in turning the complete circle was 5 min. 17 sec.

It was anticipated that the abolition of the after deadwood would tend to increase the manœuvring powers of these vessels to a considerable extent, but it was also feared that it might produce unsteady courses. To avoid this the vessels were fitted with bilge keels of rather greater length than usual, viz., 250 running feet on each side. As a result, the pilots and masters of these vessels report that they are easier to handle than steamers, in the fleet, of one-third their size, and that they make excellent courses. Experience has proved this departure to be a complete success, and very soon it will be embodied in eleven steamers of the fleet.

THE SUBSTITUTION OF TWO PILLARS FOR ORDINARY STANCHIONS.

The ordinary system of pillaring cannot be said to have many arguments to justify its existence. For the shipbuilder it is a crude and primitive contrivance, for the shipowner a costly nuisance; and in the performance of its functions it is more remarkable for its weight and obtrusiveness than its strength.

In text-books pillars are usually described as "short" and "long," in terms of their diameter, but in modern ships without lower, or orlop, decks, a new superlative would have to be invented to adequately describe the pillars now in general use. As they are of great length and have little resistance to transverse pressure, great difficulty is experienced in keeping them straight. Obstructing the stowage, they form a first aid to the stevedores in chocking off cargo; and as this is usually done with wedges, the pillars very frequently get bent. It therefore happens, even in the best regulated fleets, that a considerable percentage of the pillars are useless, either as struts or ties. Their resistance to deflection is also considerably modified by the character of their ends, and their value in many cases might be increased by greater attention to this detail. But perhaps the chief disadvantage of the ordinary system of pillaring occurs in vessels of great breadth, especially when quarter pillars are introduced. They break the stowage of the hold to such an extent that the obstructing pillars must frequently be removed, to admit bulky cargo, and very often they cannot afterwards be replaced until the cargo is discharged.

Under these circumstances, the deck is usually shored with wooden stanchions from the hold ceiling, and in some cases, where this is not accessible, the only alternative is to shore the deck from the cargo, in which case care must be taken to get a solid foundation for the stanchions, and to secure the cargo from damage. Such shores can only perform one of the two functions of a ship's pillar. They cannot easily be made into ties as well as struts. It is not surprising, therefore, that many cases are on record where these temporary shores have got adrift while the ship has been working in a seaway, thus causing the decks to collapse. Similar accidents to the deck are on record where the pillars have been carelessly replaced or left out altogether. Many accidents can also be traced to the negligence of leaving bent pillars unstraightened.

Now, in order to develop the full strength of a ship it is imperative that the top and bottom members of its girder should be rigidly tied together. It is also desirable from a shipowner's point of view that the number of pillars should be reduced to a minimum, and, if possible, the danger should be overcome that is caused by careless tampering with portable pillars, thus compromising the strength of the ship. Their diminution would also effect a considerable saving in time and money, which is generally incurred by the removal and replacement of portable pillars for the admittance of bulky cargo.

To achieve this end the main hold, shown in Fig. 4, was designed early in 1895, and has since been introduced into fifteen steamers of this fleet. The length of the hold is 75 ft., and it contains, with the 'tween decks, 6,250 tons of space, and yet its only obstruction is one pillar on each side of the hatchway. The floor of this hold has contained as many as twelve Lancashire boilers, each weighing 29 tons, which have been stowed without the removal of any part of the ship's structure. It may be of interest in passing to state that the lifting appliances at this hold have been tested up to 35 tons.

The principle adopted is that of compensating for two complete rows of stanchions by fitting two accessible box girders under the main deck, and extending the upper deck hatch coamings from bulkhead to bulkhead. The hatch coamings are converted into girders by fitting efficient flanges on the upper side, while the lower side is reinforced by fitting two channel girders under the upper deck beams. These fore and aft girders are divided into two spans, the extreme ends of which are supported by specially stiffened bulkheads, and the centre by a built pillar, the thrust of which is taken by a special stool fitted to distribute the stress over the double bottom. This system has been perfectly successful, experience proving it to be even more rigid than the ordinary system of pillaring.

It is a pleasure to record that T. and J. Harrison, of Liverpool, have fitted this system in a slighty modified form into two of their largest steamers, and have carried it throughout the length of the ship. I may add that these two vessels were classed at Lloyd's. I am also given to understand that Harland and Wolff have adopted the system, and have fitted it right fore and aft in five large vessels built for the Australian trade and owned by the White Star Line.

In the vessels forming the subject of this paper, it was considered sufficient for the trade in which they were employed to fit one hold in the manner just described and unnecessary to fit girders of such large spans in the remaining holds. However, to prevent any discontinuity of strength, the main hold girders on both decks were carried right fore and aft, scarphing into the engine and boiler casing; but as a less span was adopted in the remaining holds, the girders were made of a lighter character. This system is illustrated in the after main hold, Fig. 5.

The result of this system of pillaring has been most satisfactory, there being a complete absence of vibration, even when the vessels are in their lightest trim, and at all speeds of the engines up to a piston speed of 950 ft. per minute. When the main holds of these vessels were designed, it was predicted by some opponents of the scheme that it would be impossible efficiently to chock

the cargo to prevent chafage, owing to the absence of pillars, and that there would be heavy claims for damaged cargo. The contrary has been found to be the case, and experience has proved that these holds carry cargo with even fewer claims for chafage than vessels fitted with the ordinary system of pillaring. In other words, experience has shown that stanchions really tend to cause chafage.

THE 3-FT. FRAME SPACING.

In these vessels a 3-ft. frame spacing has been adopted. An increase in this direction has frequently been urged in times past, but the writer has been unable to discover any precedent in the merchant service where a greater spacing than 30 in. has been adopted. In a highly interesting and instructive paper, read before this Institution so long ago as 1873, Sir William White, in one of his conclusions on transverse framing, says:

> It appears that an increase in the spacing of transverse frames favours the more satisfactory development of the strength of the skin plating, without any increase in cost of workmanship or weight of material. A change in this direction has been repeatedly enforced on weightier grounds than the above, but has long been postponed. There can be little doubt, however, that nothing but advantage, so far as strength in proportion to weight of hull is concerned, would result from modifying the present system of framing, widening the frame space, and combining with the reduced transverse framing some well-considered system of longitudinal framing.

Were it not for the fact that we have had repeated examples of the distrust of change common to shipowners, shipbuilders, underwriters, and registration societies, it would appear inexplicable that such an admirable paper, so logical and conclusive in its deductions, should have lain without actual result for so many years. This is more remarkable still when it is considered that the practical advantage of a wider spacing of frames is shared alike by shipbuilder and shipowner.

The reduction in the number of frames, reverse frames, floors, frame brackets, and, it might also be added, beams, coupled with the enormous reductions in the number of rivets used in the ship, and the greater accessibility of every part, especially the ballast tanks, are matters of advantatge to builder and owner alike. They appeal especially to the shipowner, because, with a given weight, a stronger and more durable ship can be produced.

The durability of steel ships has been much discussed owing to their scantlings being 20 per cent. thinner than iron. It has also been remarked of steel that the last stages of corrosion are more rapid than the first. This is undoubtedly due to the wasted material vibrating and throwing off all applications of anti-corrosive covering. If this is to be avoided, it follows that, instead of having a large number of comparatively thin scantlings easily wasted to the vibrating stage, it is better to have fewer and thicker parts, which will give greater initial strength, with the same weight, and be more durable in the end.

The midship section of these vessels showing the general scheme of scantlings is given in Fig. 3. It will be noted that an attempt has been made to combine with the 3-ft. frame spacing a simple longitudinal system. The ship's side is divided into cells about 4 1-2 ft. by 3 ft., the longitudinals keeping every portion of the shell

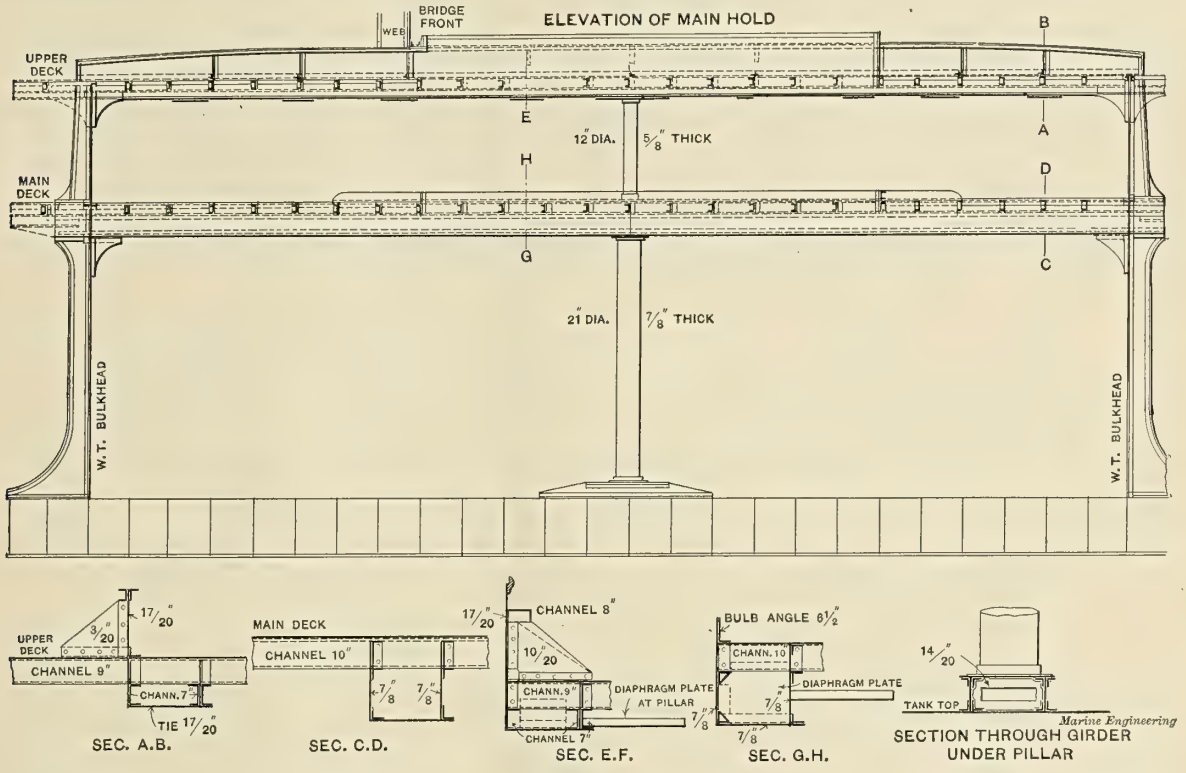


FIG. 4.

and framing well up to its work. The fore and aft girders, compensating for the omission of ordinary pillars, are also valuable longitudinal stiffeners to the upper flange of the ship-shaped girder.

None of the objections urged against the wider frame spacing have been experienced in practice. The ships have met with all kinds of weather and have stood both the pounding and hammering action of the sea with impunity. In port and roadsteads they are constantly surrounded by barges inflicting the usual amount of bumping. They also meet with the usual fending when entering locks or coming alongside quays. After considerable experience of this usage there is absolutely nothing to indicate in any of these vessels that the 3-ft. frame spacing is in any way inferior to the 2-ft spacing for resisting the local shocks that ships are subject to. It has now been adopted in this fleet of steamers as the minimum spacing.

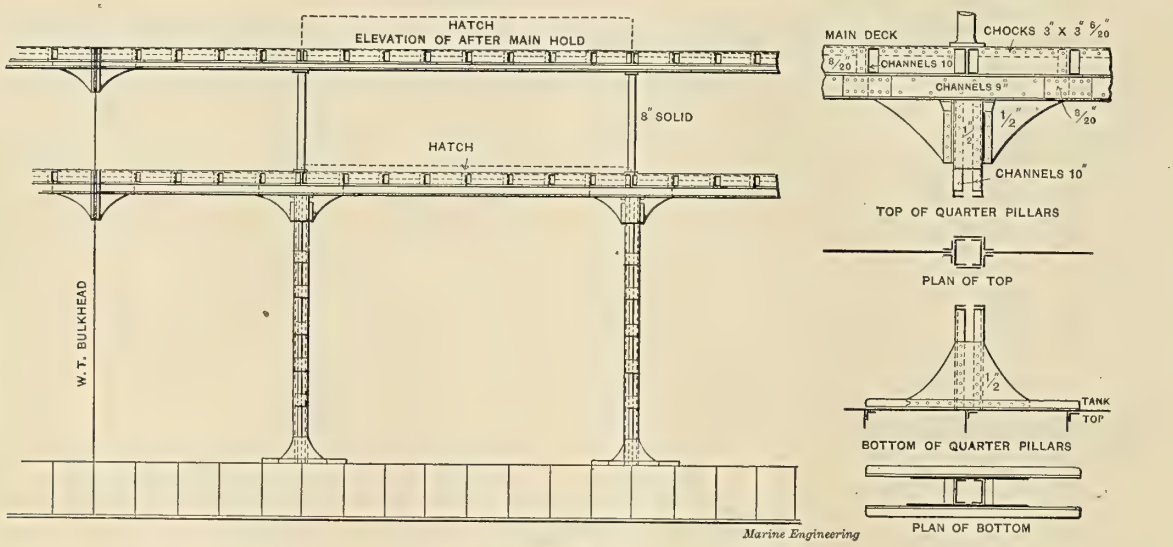


FIG. 5.

DISUSE OF CEMENT ON THE SHIP'S BOTTOM INSIDE THE BALLAST TANKS.

It was not until considerable experience of iron ships had been gained that Portland cement was adopted for preserving the inside of their bottoms. For some time this part of the ship suffered more severely from corrosion than any other. This was largely caused by the acids in the cargo draining into the bilges and setting up a chemical action detrimental to the iron. At that time sugar formed a staple trade for many iron ships, and the effect of this cargo on their bottoms was found to be most destructive.

Asphalt was at first adopted to insulate the iron from these ravages, but was found to soften in warm climates, and run down toward the centre of the vessel, leaving the higher parts and rivet heads bare. Portland cement was then tried, and has proved highly efficient in resisting the ravages of most chemicals carried in ships. It may be of interest to add in passing that sulphate of ammonia is an important exception. This chemical will turn the best Portland cement as soft as putty, and will then attack the iron, unless there has been sufficient cement to neutralize the acid. Now, when the double bottom was introduced, the drainage could no longer get to the bottom of the ship, and provision was made for it to accumulate in the wings. These were therefore cemented.

It might have been reasonably supposed that, as the tank top supported the cargo, and carried all deleterious drainage to the wings, the cement would have been removed from the bottom and placed on the tank top. This, however, was not done, and experience has long since proved that, if the wood ceiling is frequently lifted and the tank top examined, or, better still, if the wood ceiling is dispensed with and the tank top exposed to view, it is a comparatively easy matter to preserve it from corrosion.

Now, as the tank top completely insulates the inside of the outer bottom from deleterious chemicals that may be in the ship, and as cement was originally placed there chiefly to preserve the bottom against their injurious action, the question may reasonably be asked: "Why put cement there now?" The usual answer is "To preserve the rivet heads from the wash of bilge water." Now, if a shipowner can afford to carry bilge water, he can also afford to carry its antidote. But if he does not carry bilge water, what is the use of the cement? To try the truth of this reasoning, the vessels forming the subject of this paper have their bottoms inside the ballast tanks merely cement washed. The effect is a saving in deadweight of approximately 120 tons. To allow free drainage in the bottom, it is built clincher fashion, and for the same purpose the keel plate between the internal butt straps is cemented.

Again, for the purpose of insuring the tanks being pumped dry, the cement has been left off the keel plate at each centre suction, thus enabling the large trumpet-mouthed strums to be placed within 3.4 in. from the keel plate, which is an outside strake. To carry off the vapors common to all ballast tanks, they have been fitted with 6-in. ventilators. The upcast pipes ventilating the tanks under the engines and boilers are led to the forced-draught fan. Each vessel has been carefully inspected at the termination of every voyage, and after the most minute examination of the inside of the outer

bottom, no pitting or corrosion could be discovered, and the cement wash was found to be preserving the steel on the bottom as well as any other part of the tank.

IN GENERAL.

It may be of interest to add that these vessels' capacity for water ballast is about 3,000 tons, which, without bunker coal, immerses them to a draught of 18 ft. aft and 14 ft. forward. At this draught the propeller is completely immersed. This is owing, first, to the possibility of fitting, in a vessel with an overhung rudder, the centre line of the shafting nearer to the base line, and,

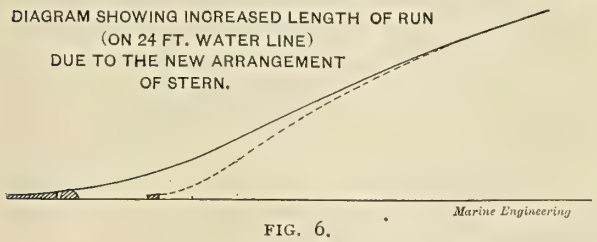


FIG. 6.

secondly, to the fact that a smaller diameter of propeller has been adopted than is usually customary. The advantages resulting from an adequate ballast draught and the complete immersion of the propeller in a seaway have been so effectually brought home to shipowners and underwriters by recent events that I need not dilate upon them. The economy is apparent, not only in speed, but likewise in the immunity from shock and consequent disaster to every part of the machinery, from propeller tip to stop valve. The diameters of propellers in the merchant service are usually designed to meet the load-draught requirements, but there are many cases where a better balance can be secured between load and light-draught performances by adopting propellers of less diameter than those now generally in use. In any vessel where the propeller is not completely immersed at ballast draught, it would be advisable to take the diameter as a factor in determining the size of the shafting.

The interesting and unusual operation of shortening a steamer has been carried out at the yard of the E. J. Codd Co., of Baltimore, Md. This boat, the *Martha Stevens*, was recently purchased by the Merchants' Transportation Co., of Trenton, N. J., and being too long by 25 ft. to allow of her operation in the Delaware and Raritan Canal, this length has been taken out. This operation leaves the boat 135 ft. long.

CHICAGO DRAINAGE CANAL.—The recent opening of the Chicago drainage canal has greatly increased the difficulties of navigation in the Chicago river, and for this reason the local authorities have planned early improvements which it is believed will eventually make the conditions better than before the opening of the canal.

OCEAN RACE.—A long distance ocean race by sailing ships is reported having ended recently at Queenstown. The British ships *Kirkcudbrightshire, Crown of Germany, Benicia* and *Sierra Miranda* left the Columbia river in company December 15 last, and the *Kirkcudbrightshire* won the race, arriving at Queenstown after a passage of 120 days. A purse was made up by the captains before sailing, and this was awarded to the winner of the race.

LAUNCHES—HOME AND FOREIGN.

S.S. AMERICAN.—At the Roach yards in Chester, Pa., on July 14, was launched the steamship *American*, of the American & Hawaiian Line. The ship was christened by Mrs. F. Farwell Long, daughter of John B. Roach. The *American* is the largest freight steamer ever built in the United States, and is one of a fleet of five, two others similar being under construction at the Roach yards and two at San Francisco, with perhaps more to follow. The dimensions of the ship are as follows: Length over all, 435 ft.; beam, 51 ft.; depth, 33 ft. to water bottom; gross tonnage, 6,000 tons. The scantlings of the vessel are in accordance with Lloyds' three-deck rules, and she will receive the highest rating in this class. The design calls for seven complete steel water-tight bulkheads and one partial bulkhead. A double bottom extends from the collision to the after-peak bulkhead. The tanks in this double bottom have a capacity of 1,250 tons. The propelling machinery will consist of a single vertical triple expansion engine with cylinders 27 in., 45 1-2 in. and 76 in. dia., by 48 in. stroke, designed to develop 2,500 I.H.P. Steam will be supplied by four single end Scotch boilers, 14 ft. 9 in. dia., and 10 ft. 6 in. long. In addition there is a donkey boiler, 9 ft. 6 in. dia. and 10 ft. long, built for 90 lb. pressure. The coal bunker capacity is 1,500 tons. The *American* has been designed to carry 8,250 tons of freight on a draft of 26 ft., at a mean sea speed of 10 knots.

S.S. VADERLAND.—At Clydebank on July 12 was launched the new Red Star Line steamer *Vaderland*. She is the first of four new steamships which the International Navigation Co. is building for the Red Star Line to ply between New York and Antwerp, stopping each way at a French port as well. The *Vaderland* is 560 ft. long, 60 ft. beam, and 42 ft. deep, with a gross tonnage of about 12,000 tons. Her average sea speed will be about 16 1-2 knots, placing her in the intermediate class of steamers. All four of the new ships will be similar and will have twin screws and quadruple expansion engines.

EIDSVOLD.—A new coast defense ship for the Norwegian Government has just been launched at the Elswick Works on the Tyne. She is 290 ft. long, 50 ft. 6 in. beam, 16 ft. 6 in. draft, with a displacement of about 3,900 tons. Her engines are of 4,500 I.H.P., with Yarrow boilers and are intended to give a speed of about 16.5 knots. Her armament consists of two 8.2 in. and six 5.9 in. b.l. rifles with eight 12 pdr, and six 3 pdr. quick firers. The armor protection consists of a belt of 6 in. Harveyized steel, with a 2 in. steel deck, and 5 in. armor on the turrets.

S.Y. VALDA.—At Lawley's boatyard, South Boston, Mass., the steam yacht *Valda* was recently launched. This yacht is schooner rigged 120 ft. long over all, 95 ft. long on the water line, 14 ft. beam and 6 ft. draft. She is of semi-composite build, and has four transverse water tight bulkheads. The engine is triple expansion with cylinders of 9, 14 and 21 1-2 in. dia. and 10 5-8 in. stroke. The designed speed is about 13 1-4 knots.

Russian A.C. Bayan.—At the yards of the Forges et Chantiers de la Méditeraneé, near Toulon, France, was recently launched the Russian armored cruiser *Bayan*. This vessel is the only one of her class in the new Russian programme, being smaller than the *Rossia* and quite distinct from the protected cruisers now under construction in America, Germany and Russia. She is of 7,800 tons displacement, 445 ft. long, 59 ft. beam and 21 ft. draft. She has twin screw engines of 16,500 I.H.P., steam being supplied by 26 Belleville boilers. The designed speed is 21 knots. The armament will consist of two 8 in. and eight 6 in. guns, with twenty 2.9 and seven 1.8 quick firers. The armor belt is 6 ft. wide, 4 ft. below the water and 2 ft. above and varies from 4 in. to 8 in. in thickness. Above is somewhat slighter protection given by a belt 3.2 in. thick. The deck is from 1.2 in. to 2 in. in thickness, while the turrets have protection of 6 in. in thickness.

S.S. Cornell.—The new steel steamer *Cornell* for the Carnegie Line was launched July 11 at the yards of the Chicago Shipbuilding Co. As with the other boats of this line, the Japanese custom of releasing a basket of doves was followed, rather than the use of the traditional bottle of wine. The *Cornell* is 440 ft. long, 50 ft. beam and 26 ft. deep. She has a dead weight ore capacity of 6,000 tons. The time occupied in her construction has been about six months.

Torpedo Boat Dale.—At the Trigg Shipyard in Richmond, Va., on July 24, the torpedo boat *Dale* was launched. Miss Mary Hassell Wilson, of Philadelphia, a descendant of Commodore Robert Dale, named the vessel. The *Dale* is 245 ft. length over all, 23 ft. beam, 6 ft. 6 in. draft, and has a displacement of 420 tons. She is one of the class of 28-knot destroyers for which contracts were let soon after the close of the late war with Spain.

S.S. Elmore.—At the yard of Joseph Supple, in Portland, Ore., on June 30 last, the steamer *Elmore* was launched. This ship is designed for the Tillamark trade and the aim has been to give her a large freight capacity on sufficiently light draft to enable her to get in and out of the harbor with regularity. At the same time she has been given such form as will insure good speed.

Ferryboat Kittery.—On July 15, at the yard of David Clark, Kennebunkport, Me., was launched the ferryboat *Kittery*. She is intended for use between Portsmouth and Kittery. All her machinery was in place as she left the ways, and she will soon proceed to Portsmouth under her own steam.

S.S. Emma Reis.—After several unsuccessful attempts the steamer *Emma Reis* was launched on July 13 at Milford, Del. She is 115 ft. long, 20 ft. beam, 8 ft. draft, and is intended for passenger and freight service between Milford and Philadelphia.

Tug Richard Caswell.—The steel tug *Richard Caswell* was launched July 7 at the yard of the Columbian Iron Works. This tug is intended for use in connection with the Government improvements about to begin on the Cape Fear River, North Carolina. She has a length of 84 ft. 6 in. over all, a beam of 18 ft. and a depth of 9 ft. 4 in.

Oyster Dredge.—At McDonald's yard, Fairhaven, Ct., a modern type of oyster dredge has recently been launched. The owners are the Narragansett Bay Oyster Co. The boat is 40 ft. long and has a 16 horse power Globe gas engine for propulsive power. The boat will be used for catching star fish and taking up oysters on the Company's beds in Narragansett Bay.

Barge Major Barrett.—At the yards of the Jackson & Sharp Co., in Wilmington, Del., on June 20 last, was launched the sea-going steam barge *Major Barrett*, constructed for the Barrett Mfg. Co., of Philadelphia, Pa. This barge is built for sea-going purposes and is designed especially to carry tar and pitch between Philadelphia, New York and Boston.

Tugs Genessee and Mahony.—These two steel tugs built for the L. V. R. R. Co., were launched at the shipyard of the Burlee Dry Dock Co., in Port Richmond, on June 21 last. The boats are each 105 ft. long, 21 ft. beam and 12 ft. 6 in. depth. They are each fitted with single screws and engines of 650 I.H.P.

Prinzessin Victoria Luise.—This magnificent new twin screw cruising yacht of the Hamburg-American Line was launched at Kiel June 29 last. At the special request of Emperor William, the christening ceremony was performed by Countess Von Waldersee, who was formerly Miss Lee, of New York.

Tug Ada Weaver.—On June 28 last at the yard of J. W. Brooks & Son, Madison, Md., was launched a new wooden tug built for Philip Weaver & Son, of Baltimore. The boat will be taken to Baltimore to receive her machinery at the works of the E. J. Codd Co.

S.S. Mineola.—At Sunderland, England, was recently launched the first of the steel steamers building for C. W. & J. Hogan, of New York. The dimensions of the *Mineola* are: Length b.p., 390 ft.; beam, 51 ft.; depth, 31.4 ft. She is provided with single screw triple expansion engines.

S.S. Devonian.—The Leyland Line steamer *Devonian*, a sister ship to the *Winifredian*, was launched on June 28 last at Belfast. Her dimensions are as follows: 552 ft. 5 in. long, 59 ft. 3 in. beam, and 28 ft. 9 in. deep.

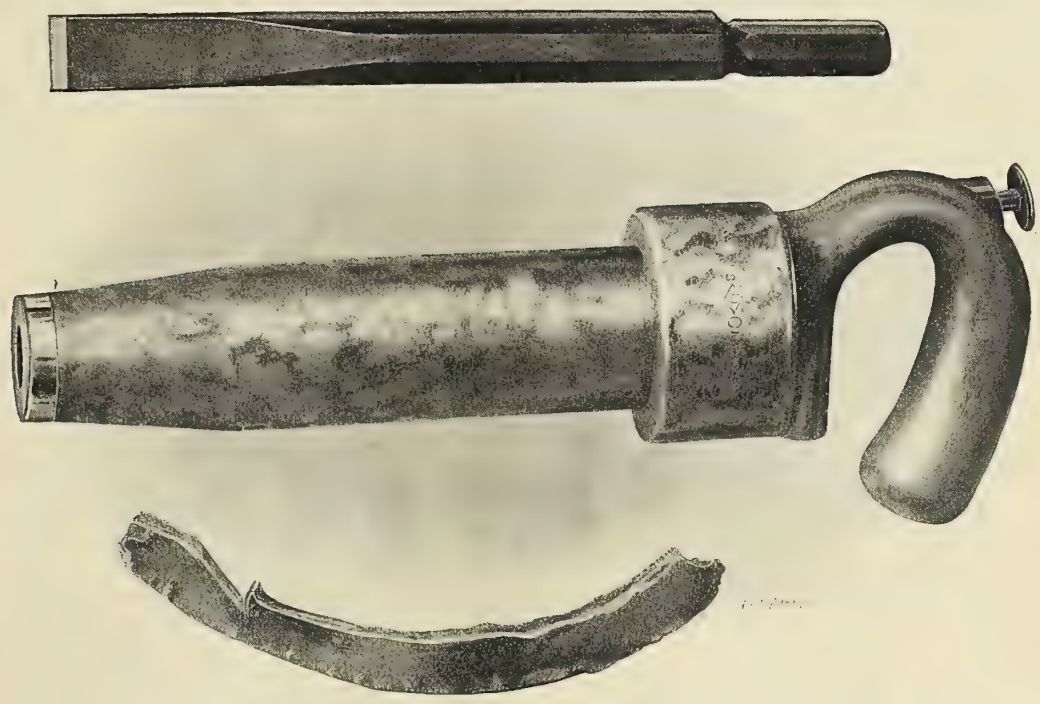
Salvage Case.—The owners of the British tug *Blazer* have been awarded $15,000 by the Admiralty Court for services rendered the Anchor liner *Persia*, while the latter vessel was under charter to the British Government as a transport. The *Persia* was on her first outward voyage to the Cape of Good Hope in the Government service, and when a few miles from the Cape de Verde Islands, broke her shaft. Under the influence of the trade wind the vessel commenced to drift toward the rocky shore, finding bottom to anchor in when within a mile of the rocks. A boat had been sent away to get help from St. Vincent, and fortunately found the tug *Blazer* in the harbor with steam up. The tug immediately went out and brought in the *Persia* safely, and repairs were then effected. The *Persia* was valued at $100,000, and had a valuable lot of stores in her hold. Besides saving the ship for her owners, the tug enabled them to complete their contract with the Government, a matter which would call for the consideration of the court.

IMPROVED APPARATUS.

Pneumatic Hammer.

The hand pneumatic hammer has to-day become a necessity in all ship yards and shops where chipping is to be done, and it is also rapidly making its way into use for the driving of rivets in all classes of riveted work. One of the drawbacks to the use of the tool has been the jar communicated to the hand and body of the operator.

In the hammer shown in the cut the claim is made that a tool has been produced which will do the heaviest duty required without excessive jar or shock upon the operator. The hammer is of the "valve long stroke" type, the valve being of substantial design and not liable to break. The handle is firmly fastened to the body by a collar-locking nut, which can be easily removed; and all working parts are made of steel carefully hardened and accurately ground to gauge, insuring durability and long wear.



PNEUMATIC HAND HAMMER.

The handle has a pistol grip, and the admission valve is so designed that the operator has an instant and sensitive control of the strength of the blow he wishes to strike, so that even with the largest size he can instantly change from the full power of the hammer to the lightest cut desired.

The shank of the chisel does not require machine shop fitting, it being only necessary to make it a good smith-shop fit in the bushing of the hammer, and to cut the shoulder the proper length from the end.

These hammers are made in three sizes, weighing from 10 lb. to 12 1-2 lb., and consuming from 15 cu. ft. to 21 cu. ft. of air. They are guaranteed by the makers, Thomas H. Dallett & Co., of Philadelphia, Pa., to be well made in all respects, and against all defects for a period of one year.

Modern Prismatic Marine Glasses.

For many years the accepted form of field and marine glass was the long single-barreled tube with the erecting eye-piece. These, however, were of awkward length, difficult to hold steadily, and lacking in illumination for the higher powers. Later came the double or binocular form, invented by Galileo and improved by Dolland, which until a few years since remained the standard form of marine glass. About 1850, however, the Italian engineer, Porro, invented a form of double reflecting prism which would effectively serve to invert the image formed by an astronomical telescope, and therefore to show erect an object seen by such an instrument. This discovery, however, bore no fruit until 1895, when Carl Zeiss, of Jena, took up the study of the best optical combinations for field and marine glasses. It was then that use was found for Porro's discovery, and by the application of such prisms it was found possible not only to reduce their length by more than one-half, but also to replace the clumsy erecting eye-piece with the simple astronomical eye-piece, thus securing compactness of form with the benefit of a long focus. The chief advantages claimed for this form of optical combination are three: A much larger field of vision, more perfect definition, increased light efficiency. Since the first advent of glasses of this character several of the leading makers have taken the matter up, and different forms of such glass are on the market, all, however, more or less immediately related to the Zeiss form and design. More recently the Warner & Swasey Co., of Cleveland, O., have taken up the study of this problem, and as a result have produced the glass shown in the figure.

This company brought to the investigation of the problem a long experience in the construction of optical tubes, ranging from those for the great Lick and

Yerkes telescopes to the telescopic gun-sights and range finder telescopes and sextants as used by the army and navy.

It was the especial aim of this company to develop independently, and from the scientific and engineering standpoint, the best possible type of field and marine glass of the Porro prism form. As one notable result of this study, it is stated that the total number of pieces contained in the form developed is less by twenty

PRISMATIC MARINE GLASSES.

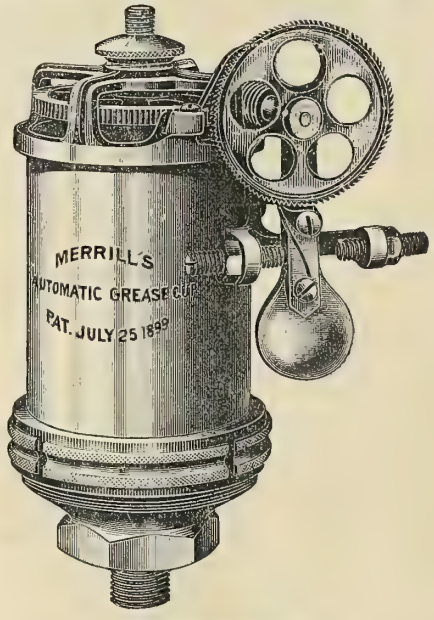
than will be found in other instruments of similar type. This is a gain in simplicity, without at the same time involving any sacrifice in use, efficiency, or convenience.

An especial point is also made of the fact that by the combination of each eye tube, cap, and hinge in a single piece, all liability of change in the alignment or collimation by accident or rough usage is avoided. The two sets of optical parts with their tubes are hinged together as shown in the cut, thus permitting of an adjustment for varying distances between the eyes. The adjustment for focus for each tube is also separate, thus providing for the commonly existing difference in focus between the two eyes of most persons. A convenient numbered scale is also provided, so that once these adjustments are determined they may be readily made again at a future time.

The field covered by this instrument has an angular opening of 4 3-4 degrees, and the magnifying power is 8 diameters, while the weight is but 11 ounces. This degree of magnification is believed to be as much as is consistent with the best illumination and with the possibilities of steadiness for a glass held in the hands. A somewhat larger size, giving a magnification of 10 diameters, is also made, but requires an especially steady hand to give the best results. Messrs. Warner & Swasey publish a little booklet giving full description of these glasses, together with hints as to their use, and an interesting list of astronomical objects which may be studied with interest and profit by their aid. This booklet will be sent to any address on application.

Automatic Grease Cup.

This cup is intended for attachment to any reciprocating or oscillating part of engines or machinery requiring constant and reliable lubrication, such as crossheads, connecting rods, eccentric straps, etc. As it feeds grease instead of oil, it may be attached in any position desired, feeding vertically upward or downward, horizontally, or at any angle. The cup feeds only when the part to which it is attached is in motion, so that no feeding or loss can occur after the engine is shut down. The base of the cup is screwed firmly into the part to be lubricated, while the body is attached to the base by the union nut or enlarged ring at the top. When this is unscrewed the upper part is all taken off together, the barrel is filled with a charge of grease, returned, and clamped into position by the union nut. The feeding is accomplished by the pressure of the piston, and this pressure is applied by the vibration of the pendulum seen at the front. By the adjustment of the stop screws at the side, the pawl attached to the pendulum may be made to take from one to six, or more, teeth of the ratchet wheel for each vibration of the pendulum. On the ratchet wheel shaft is a worm which meshes into the large worm wheel at the top. The central screw or spindle is



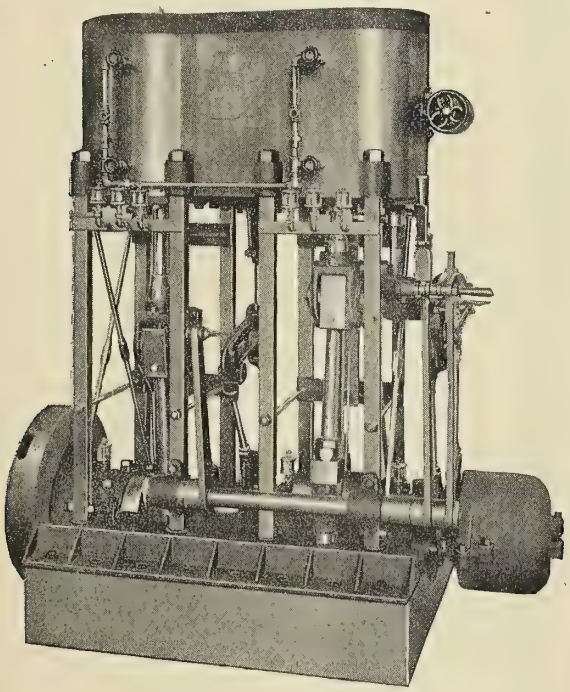
AUTOMATIC GREASE CUP.

splined, and revolves with this wheel at the same time that it travels downward by the operation of its thread in the central nut, which is screwed into the bracket or guide at the top. As long as the vibrations continue the feeding goes on, until the piston reaches the bottom and the grease is all expelled. To raise the piston for refilling the barrel, the central nut, which has a milled and notched head, is unscrewed from the

bracket, the piston is pulled up, the nut is whirled down the screw by hand, and screwed tight in its place again. The ratchet wheel may be pulled round by hand until the slack is taken up and feed is fully established, and if at any time it is desirable to feed in an extra quantity of grease, this also may be done by turning the ratchet wheel. The lubricator may be made of any size and for any rate of feed desired. Any of the usual kinds of grease may be used in the lubricator, and any percentage of pure graphite may be mixed with it. The worm is of steel, the pawls are of steel hardened, and the wheels are of hard bronze. The lubricator was designed and patented by G. U. Merrill, of Paterson, N. J., and is made and sold by James L. Robertson & Sons, 218 Fulton street, New York.

Reeves Compound Yacht Engine.

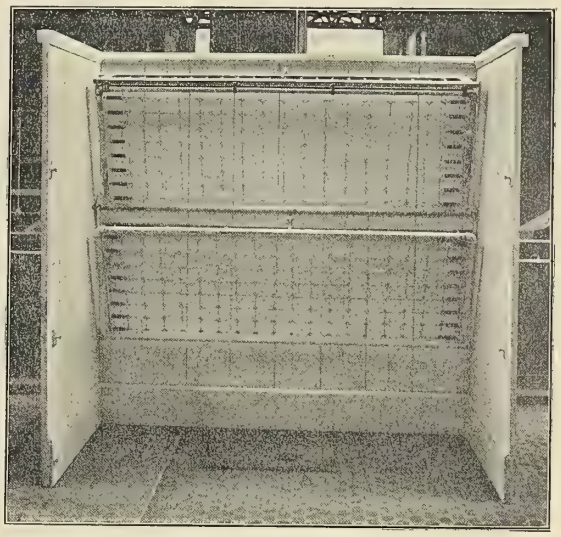
The especial feature of the yacht engine shown in the cut is found in the valve gear. The valves are of the simple piston form, and are each operated by a link. A special device for controlling the links enables the low pressure cut-off to be set at any desired point, independent of the high pressure link. At the same time, when it is desired to stop or reverse, it is only necessary to operate the main lever, both links being under its control so that they move as one. In this way the low pressure link can be set in such position as may be determined by experiment for the best results at any given point of high pressure cut-off, but without introducing any additional difficulty of manipulation. These engines are made in various sizes by the Reeves Machine Co., of Trenton, N. J., who are prepared to furnish estimates either for engines alone or for complete steam yachts.



COMPOUND YACHT ENGINE.

Metallic Berths.

Among the many details which mark the modern improvement in ship fittings, by no means of least importance are those which have transformed the old cumbersome, dirty, vermin-breeding berth into the modern metallic cleanly substitute. The berth shown in the adjoining cut is made by Lein, Irvine & Co., of New York city, and has been designed especially with a view to simplicity and durability. When not in use they can be folded up and out of the way, thus greatly increasing the freedom in the living spaces of the ship. They are also so made that they may be taken down and put up without the use of special tools. With the upper berth folded up out of the way, the lower berth can be used as a lounge or couch. The same company also manufactures all forms of steel and wood bed springs, mattresses, pillows, and bedding equipment.



METALLIC FOLDING BERTH.

On June 28 the *Oregon* while proceeding from Hong Kong to Taku struck on a pinnacle rock in the Miao-Tao strait in the gulf of Pe-Chi-li. There was a dense fog and the ship had anchored, sent out boats to sound, and then later got under way, soon after striking on the rock. At first grave fears were entertained that it would be impossible to save her, and that after her glorious career at Santiago, she would become a wreck upon a treacherous rock off the China coast.

It is not too much to say that the whole nation rejoiced when, on July 5, Secretary Long received a telegraphic report that she had been floated, and later another to the effect that the injuries were not serious and that comparatively simple repairs would be sufficient for present purposes. He immediately wired congratulations and instructions to make only such repairs as were needed to place the ship in condition for service, so that we may soon hope to learn that, as Secretary Long called her, the *Constitution* of the present generation has again taken her place in the fleet, like her prototype of former years, fearing nothing and ready for whatever service may be required.

MARINE ENGINEERING

PUBLISHED MONTHLY

BY

ALDRICH & DONALDSON,

309 Broadway, New York.

Editorial Department,
H. F. DONALDSON.

Business Department,
H. L. ALDRICH.

Branch Offices,

Philadelphia, Pa., Mach'y Dept., The Bourse, S. W. ANNESS.
Detroit, Mich., Hodges Building, L. L. CLINE.
Chicago, Ill., Monadnock Block, S. W. HUME

TERMS OF SUBSCRIPTION,

	Per Year.	Per Copy.
United States, Canada, and Mexico.....	$2.00	20 cents.
Other countries in Postal Union....	2.50	25 cents.

Entered at New York Post Office as second class matter.

Notice to Advertisers.

Copy for changes in advertisements must be in our hands not later than the 20th of the month to insure changes being made in the issue of the month following, and not later than the 15th of the month if corrected proof is to be submitted.

NEW YORK and its environs has experienced fires many and disastrous, but perhaps none which came so like a thunderclap from clear sky as the conflagration of June 30, which resulted in the destruction of the docks and ships of the North German Lloyd Co., in Hoboken.

The account of this fire, as summarized elsewhere in the present issue, furnishes food for serious reflection and gives material for many lessons. Of these we can here refer only briefly to the more prominent.

The rapid spread of the fire seems to have been due to the existence of a series of favoring conditions: the presence on the docks of large quantities of combustible cargo; the presence of wood in the docks and sheds dry and more or less soaked with oil and tar; the existence of a high wind and the absence of adequate means for fire control at the dock itself. In other words there was the presence of all elements necessary to the rapid spread of the fire; and the absence of means adequate for its control. These facts point to two conclusions: The need of fireproof construction, so far as may be feasible, for docks and sheds, and the need of more efficient apparatus for fire control at the docks and ready for instant use. In the first moments of this fire a single stream of water well directed would have controlled the situation and prevented the entire horrible catastrophe.

Another fact impressed by this fire is the enormous amount of inflammable material, considering both fittings and cargo, which is contained in a modern ship, even though she is primarily a structure of steel. As a general truth, this, of course, is well known, but the possibilities of rapid and fierce conflagration in such structures have received new and startling demonstration in the Hoboken fire.

We can hope for little improvement, of course, so far as the cargo is concerned, but relative to the ship herself it is a question if much might not be done by the adoption in some measure of the warship fireproof style of construction and fitting. While not carrying these ideas to the same extent something might be accomplished by a decrease in the amount of wood fittings and the omission from the passenger ship of tons and tons of inflammable material, which contribute only to forms of barbaric decoration, and which have no place where they may by any chance play a part in endangering human life.

The truth is that while the subject of fireproof construction for structures on land has attracted great attention and study and has been carried to a high degree of development, the fittings and equipment of ships have been carried out in almost entire disregard of these considerations. It is time that the possibilities of danger from these sources were more keenly realized than they have been hitherto.

The most shocking feature of the catastrophe was the loss of human life. Nearly three hundred persons burned alive or drowned as the result of a burning cotton bale. It appears that many of these deaths, perhaps most of them, occurred by the imprisonment of the victims below decks, either by closed hatches or by the fire itself. The appearance of faces and waving arms at the deadlights told a story of human agony of mind and suffering of body, which those who saw will perhaps long be unable to forget.

Had a few of these openings been of sufficient size to admit the passage of the body, many or most of these victims might have been rescued. It is not a question of enlarging all of the deadlights; one or two in each compartment or passage would have perhaps been sufficient. The thing is perfectly simple, only slight enlargement would be required, but the especial need of such ways of exit or escape have perhaps never before

become so plainly apparent, and so it has not attracted the attention which its importance merits.

The lack of organized and calmly directed effort to control the fire and to save human life seems also a distressingly sad fact. The wholesale charges made against tugboat captains and crews are admittedly incorrect or founded on exaggerations. While doubtless examples of undue greed were not lacking, it is not to these charges that we refer, but rather to the absence of means, material or human, adequate for grappling and dealing with such a situation. If detachments of bluejackets from the Navy Yard could have been hurried to the scene, men fearless of danger, devoted to duty, and in charge of cool and experienced officers, if such squads of men could have been on the spot with the sole aim of saving human life and property, perhaps the tale of the lost might have been lessened.

The cost in human life was terrible and in property enormous. Let us hope that some of the lessons so plainly shown by this catastrophe may sink deep into the hearts of those who have the power to move for better things in the future.

THE British *Belleisle* gunnery experiments have naturally attracted much attention from the technical press, both at home and abroad, and "lessons" many and varied have been drawn. Among these we have noted one regarding the ordinary form of small boats, the certainty of their destruction if carried in the usual places on deck, and the uselessness of depending on such means either for escape or for boarding. This lesson, however, can hardly be called new, for it was long ago learned and practised in both the Chino-Japanese and the late war between the United States and Spain. Valuable lessons are doubtless to be drawn from these experiments with the *Belleisle,* but the danger to small boats is already too well known to need further demonstration in this manner or at the present day.

What is now needed is an adequate substitute not subject to the same risk of destruction. The suggestion of collapsible boats which may be stowed below or in a place of relative safety is perhaps worthy of consideration, but at the best such could be only considered as a last resort provision. On the other hand the increasing evidence that the sinking of an armor clad ship is not as likely a result of naval warfare as we have been led to believe may indicate that the need of boats for escape will be correspondingly decreased.

On the contrary, however, the need of boats for boarding or for making sure of a victory may be as great as ever, and the ship which is shorn of every possible means of clinching a victory and of readily placing a prize crew on board, will to that extent fall short of the ideal toward which all naval construction must aim.

AT the beginning of the present decade the few vessels of the type of the *Paris* and *Teutonic* represented the forefront of the advance in fast ocean steamships, and even now these may still be called fine ships. Early in the decade, however, came the *Campania* and *Lucania* with many head shakings as to the policy of ships of such size, only to be far distanced more recently by the *Oceanic.* Then came also the Germans with their monsters culminating in the *Kaiser Wilhelm der Grosse* and the *Deutschland,* whose maiden trip we summarize on another page. Comparing the *Paris* with the *Oceanic* we find a nearly doubled displacement for the latter, but with no sensible increase in speed, such being the purpose of the designers. Turning to the *Deutschland,* however, we find a speed of 23 knots, an advance of from two to three knots for the decade. Unless all signs and rumors fail, moreover, the *Deutschland* will not long have the field uncontested, and we may look with confidence for advances in the coming decade perhaps not less notable than those of the past.

WE publish elsewhere a communication from a correspondent relating to certain improvements in the development of power, for the propullsion of steamships, and incidentally, we suppose, for other purposes as well. We suspect that our correspondent has either been indulging in a "midsummer night's dream," or else that he is a bit of a wag and sends this letter as his contribution to the usual midsummer crop of freak ideas on this and similar subjects. We publish, however, the communication without prejudice, and assure our correspondent that the prospects for success by the methods which he outlines are quite as good as by those involving either liquid air, or electricity in the manner discussed in our issue for July, and to which he refers at the opening of his letter.

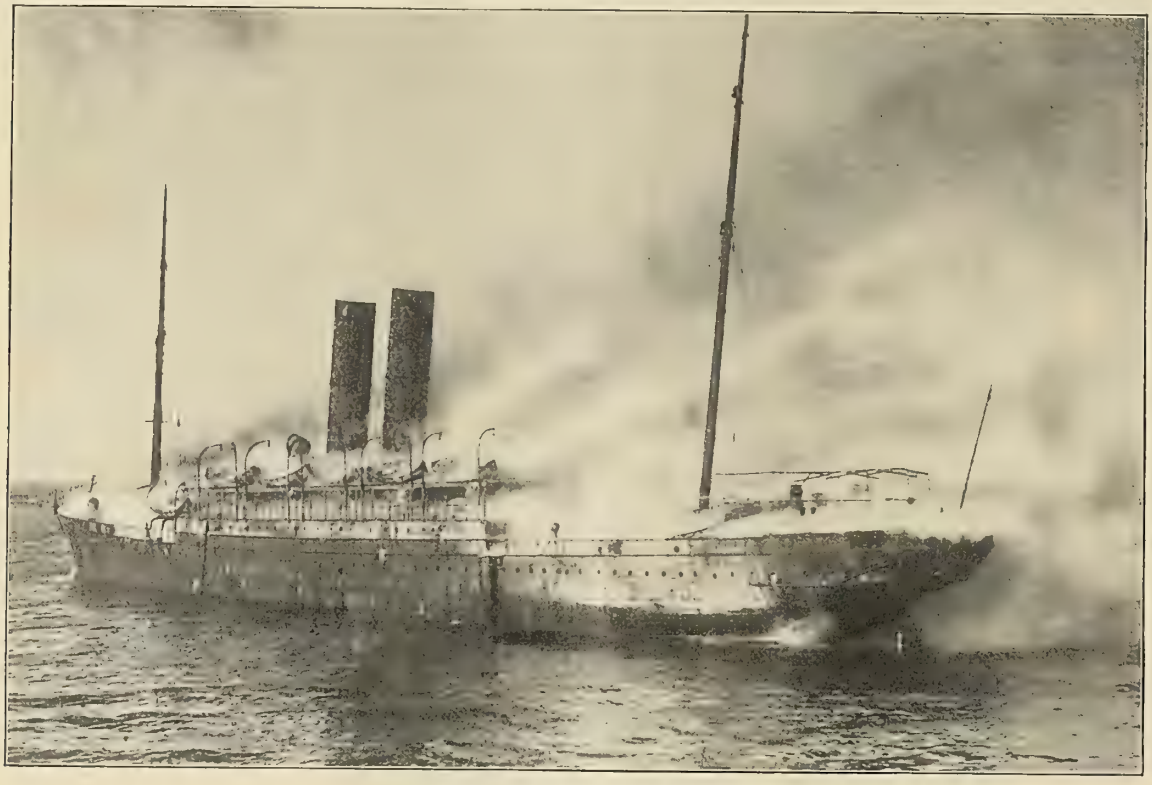
SHIPS AND DOCKS OF THE NORTH GERMAN LLOYD STEAMSHIP CO. DESTROYED BY FIRE.

On the afternoon of June 30 occurred the most appalling and destructive fire ever known in the piers and shipping of the Port of New York. Nearly three hundred lives were lost either by burning or drowning, the four large piers and sheds of the North German Lloyd Co., at Hoboken, with large quantities of cotton and general merchandise were completely destroyed, the steamers *Saale, Bremen* and *Main* were for hours raging furnaces, and when the fires died down for lack of further material on which to feed, little was left but the metallic parts of the structures, and much of that in a twisted, blackened and useless condition. The new steamship *Kaiser Wilhelm der Grosse* was also badly scorched, but fortunately escaped without more serious injury. The total loss of property has been variously estimated from $6,000,000 to $10,000,000, only in part covered by insurance.

The fire seems to have started in a bale of cotton, just how is not clear, but once under way it spread with almost inconceivable swiftness, due in large measure to the inflammable materials at hand and to the high wind prevailing at the time. In a short quarter of an hour from the start, the four piers and their warehouses were enveloped in the flames, which soon extended to the ships moored alongside. The *Kaiser Wilhelm der Grosse* was quickly pulled out and escaped with but slight injury. The *Saale* drifted out and down the stream, burning as she went her way, a menace to all shipping in her path, while helpless human beings were imprisoned and perishing below. The *Bremen* also floated out into the stream in like condition, while the *Main* burned and sank near the docks, also with its complement of perishing humanity.

On the *Main* sixteen men took refuge in the coal bunkers, lived through the terrible experience, and were rescued after the flames died down. In addition to these large ships several barges and lighters loaded with cotton and other merchandise caught fire and either burned at their moorings, or drifted out into the stream and burned as they made their way down the river. On these also men were burned, or jumping into the river were drowned or rescued by passing boats.

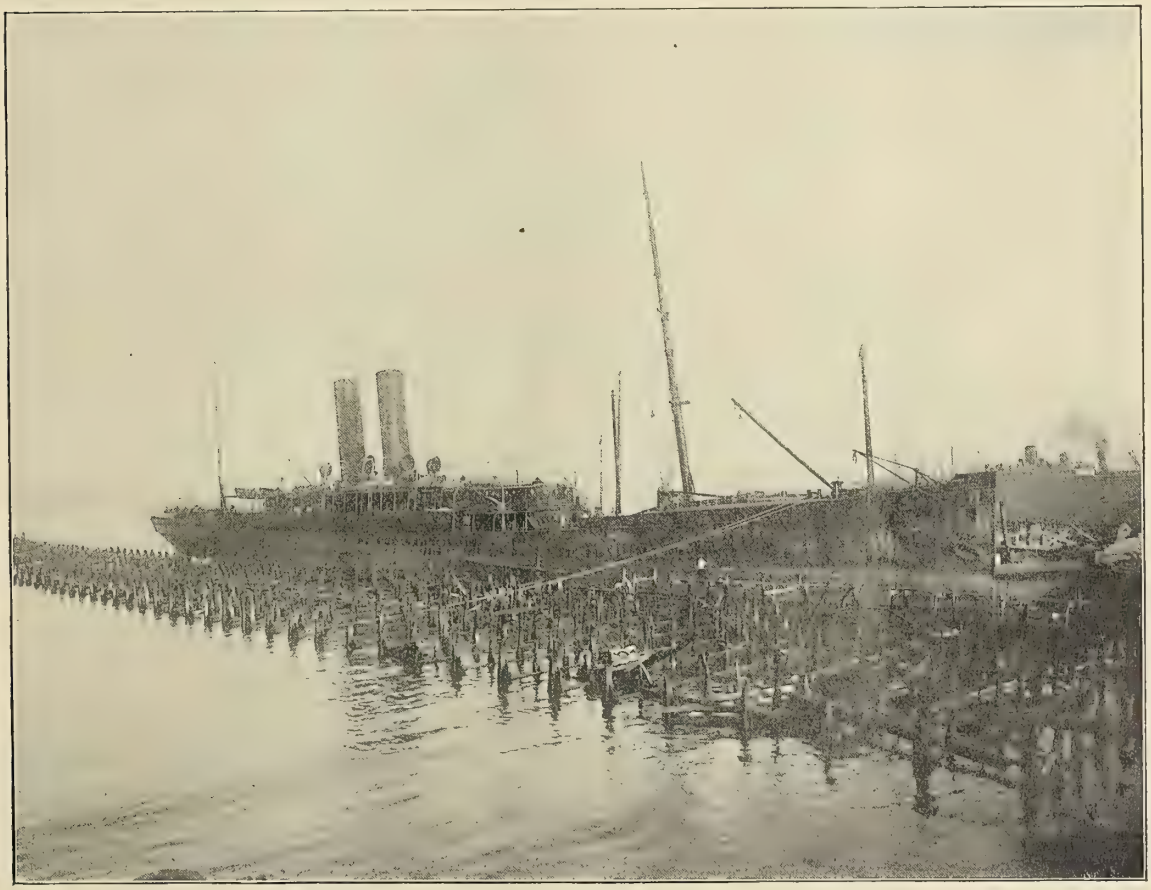
The flames were also communicated to the Campbell stores adjacent to the piers, in which were stored large quantities of jute and whiskey. These burned with such fierceness that the firemen could not come within fighting distance, and the flames had their own way until the buildings were entirely destroyed.



S. S. SAALE ON FIRE AND DRIFTING DOWN THE RIVER.

The most terrible feature of the fire was the loss of life by burning and drowning. So rapid was the spread of the fire that before due realization was had, or warning could be given to those in the holds of the ship, they were enveloped in flames and all escape was cut off. The lower portholes were open and to these the imprisoned victims crowded, shouting for help or waving signals of distress. But all in vain, for while within easy sight and hearing of those in boats about them, no help could be furnished, and overcome by the heat they perished before the eyes of those looking on, but powerless to aid.

S. S. BREMEN AND MAIN ON FIRE NEAR THE HOBOKEN DOCKS.



S. S. SAALE RAISED AND RETURNED TO HER DOCK AFTER THE FIRE.

Many also perished by jumping from the docks and ships into the water, and drowning amid the confusion which prevailed.

Regarding attempts to control or subdue the fire, the city fireboats were on hand and did what they could, but were utterly inadequate to check or in any way control the situation.

From the docks an alarm was sent in, but so rapid was the spread of the flames that the local fire department was unable to more than afford some protection to neighboring property.

There is evidence that the docks were equipped with fire apparatus considered ample for any circumstances likely to arise, and that a hose located only some 30 ft. from the outbreak of the fire was immediately brought into use, while other apparatus was brought forward into action as rapidly as possible. Even so, it shows how utterly inadequate was this provision for the circumstance which arose, or perhaps we should say, how utterly beyond anything which might be expected were the especial circumstances of the fire.

As to the final fate of the ships, the *Saale,* drifting down the river, finally grounded on the Jersey flats and burned out. Since then she has been pumped out, the work of removing the dead has been completed, and the ship has been disinfected and towed back to the burned docks.

Similar work on the *Bremen* and *Main* is also under way, and when completed a thorough examination can alone determine the next steps to be taken. On all three of the ships, except possibly the *Main,* repairs seem to be practicable, and we may hope that in spite of the terrible experiences of the fire, further years of usefulness yet remain to these ships.

VIEW OF THE BURNED PIERS.

Loss of S. S. Georges Croise.—A grave charge of cowardice has been made against Captain Francisco Catrain and the officers of the steamship *Georges Croise,* which recently sank at the mouth of the River Ozama, Santo Domingo. The vessel was an old steamer of about 355 gross tons, engaged in trade between Santo Domingo and Cuban ports. The vessel came out of the harbor at about the time that the S. S. *New York,* of the Clyde Line, had arrived to pass in. When the *Georges Croise* crossed the bar she was seen to list suddenly to starboard, and in less than fifteen minutes she sank in deep water. Boats from the *New York* reached the sinking vessel in time to take off the passengers, most of whom were Cuban refugees returning to their homes in Santiago. The captain and officers of the sinking vessel had already got away in one of the boats, leaving the passengers to take care of themselves. After the rescue, when the *New York* reached her pier, she was visited by President Jiminez, who publicly thanked Captain Proctor and his crew.

CORRESPONDENCE DEPARTMENT.

Editor of Marine Engineering:

SIR: I am constrained to write to you concerning my improved form of marine engine or Bovoid Motor—my draftsman flippantly calls it the "beefsteak engine"—as I noticed that the liquid air and electric experts are making such impossible claims, as you very properly point out in your last issue.

I believe that the great mistake which investigators have made in the past has been the attacking of the problem of energy transformation from the inorganic side of the question. The forces in organic nature are not realized, even in this age of science, to anything like the extent they merit. Let anyone take a walk along the countryside and note the manifestations everywhere in the peaceful landscape, of the enormous inanimate non-returnable forces which, in synchronism with the inter-planetary fluctuating pressures, nourish the fibro-vascular elements of the leafy shoot, and project the tall timbers to an altitude far above the height of puny man. Even the city dweller will note the weighty flagstone moved from its bed by the tiny umbrageous shrub, which by the infiltration of a chance seed has tapped the nourishment of earth.

But to leave the domain of philosophical science for the practical sphere of marine construction. I have succeeded in adapting the humble beast of the field to a work more useful, though not less vital, perhaps, than the sustenance of the crew and passengers of a ship. My attention was first drawn to the subject on a transatlantic trip, in noting the great wastefulness in the culinary department. Hundreds of pounds of meat, representing millions of thermal digits were cast overboard in both the cooked and raw conditions while at the same time the vessel was carrying hundreds of tons of inert coal for use in the monstrously unwieldy and dangerous boilers. I cannot give you more than a brief outline of my process, for as yet patent rights have not been secured, and the psychological moment for the exploitation of my apparatus has not arrived, the interests of civilized peoples being now concentrated on self destruction, witness the Boer and Chinese wars.

But to resume. It will be conceded by every scientist that 1 lb. of beef will sustain one man for 24 hours, with the necessary water. Now, allowing double this amount, and assuming eight men equal to one horse (a liberal allowance), we get for 20,000 I.H.P. a total daily consumption of less than 150 tons of beef. Compare this with coal, which, under favorable conditions, would call for more than 300 tons dead weight for the same horse power. Thus at once we get rid of fifty per cent of the present weight and bulk in the bunkers. Then for the present enormous boilers and contained water we substitute my "macerator." This is fitted with a hopper into which beef is deposited in suitably sized pieces. In a large vessel a buzz saw would be used to reduce the frozen carcases to the proper dimensions. In this macerator the latent energy of the meat is extracted and the refuse muscular structure is separated out. I found enormous difficulty in perfecting the "eviction valve" in this machine, whereby the refuse matter is thrown out and the energy—"rotian" I have termed it—safely housed. So great is the etheric intensity of the latter that were it permitted to escape into the interior of the ship it would instantly combine with the spiegeleisen in the hull plating and by increasing atomic attrition lead to the speedy dismemberment of the vessel. Long experimentation was also necessary before there was any real progress in transforming this rotian into useful work. It was here indeed that the well known economic law discovered by the engineers of Ancient Rome, *Ex Nihil nihilum, in nihilum nil posse reverti,* was availed of. The refuse which I term "epistrophe" as it is used again, is saturated with the oils of the fat (also separated out in the macerator) and compressed into briquettes which are utilized to warm up and vitalize the rotian in the "flatus tank" or "equalizer," which is connected in series with the macerator.

It is important here to get two results, a sufficient density of rotian combined with a proper temperature, permitting a subsequent extension (not expansion as in the steam engine) along an adiaphorus curve. By an ingenious combination of the differential thermopile and the integrating bolometer in one instrument, the correct point of liberation is read or registered, and the rotian automatically passes on to the Bovoid Motor, or, as my assistant is pleased to term it, the "Beefsteak Engine." In this engine by actual dynamometric measurement I have secured a pressure of 500 ft. tons per sq. in. of cross sectional crank pin area, at a rate of consumption of beef at the macerator, not exceeding 60 lb. per hour.

My engine is vastly more compact than the steam engine, and by getting rid of all vibratory disturbances on account of the synchronism of the piston movements with inter-planetary pressure fluctuations by barometric regulation, I can decrease engine room weights materially. I use the ordinary method of screw propulsion, and make no claim whatever to any original investigations in this direction, contenting myself with the more sublime problem of co-ordinating the elemental forces that nature has freely given us in one effective direction, viz., the propulsion of ships. I should have been much further advanced with my work but for an explosion of gas in my laboratory, which wrecked all my apparatus, and prevented a preliminary trial during the Spanish war.

Yours respectfully,

PHINEAS LAMBERT.

JAMES GORDON BENNETT'S YACHT.—Work on the hull of the new steam yacht for James Gordon Bennett, from Watson designs, is well advanced at Denny's yard at Dumbarton, Scotland. The design of this vessel is very peculiar, calling for a straight stem, great overhang at the stern, straight funnel and single pole mast abaft the funnel. The vessel has been the subject of a number of tank experiments at the Dumbarton yard, and it is expected that she will be very speedy. Not less than 18 knots is looked for on the trial trip. The interior arrangements are rather unusual in that the number of separate rooms will be small and the dimensions of each large.

It is announced that the New York Shipbuilding Co., with yards at Camden, N. J., has secured two important contracts.

EDUCATIONAL DEPARTMENT.

HELPS FOR CANDIDATES FOR MARINE ENGINEERS' LICENSES—FIREROOM—III.

BY DR. WILLIAM FREDERICK DURAND.

ROUTINE AND MANAGEMENT.

Sweeping Tubes.—In addition to the cleaning of fires, the tubes will require cleaning from time to time, dependent on the character of the coal and other circumstances. With soft coal and moderate draft they will soon become partly filled with soot and ashes, thus choking the draft still further, and preventing the transfer of heat to the water through the metal of the tube.

To prepare for sweeping tubes the draft is checked, ash-pit doors put up, furnace doors opened and front connection doors raised. Care should be taken to wait until the fire is burned partly down before doing this, so that the circulation of air through the grates may not be shut off while the fires are too heavy, thus endangering the grate bars. For cleaning the tubes the ordinary wire tube brush may be used. This consists of a mounting carrying wire bristles and fitted usually with a jointed handle by means of which it is pushed and pulled through the tubes, thus cleaning out the soot and ashes collected there. A more modern method consists in blowing through the tubes with a steam jet. The mounting of this appliance consists of a flange or conical ring fitting closely to the end of the tube and provided with a steam nozzle directed along the center of the tube. A handle is provided for holding and guiding the apparatus, and steam is led to it by means of a flexible hose. By this means the ashes and soot are driven out of the tubes into the combustion chamber. By still another form of apparatus the jet is not directed into the tube but across the front end producing a suction, and thus drawing the ashes and soot to the front connection and discharging them up the funnel.

The operation of sweeping tubes is one that is necessary to maintain the continued efficient operation of the boiler, but it must not be forgotten that it involves a serious disturbance to the draft of the whole battery, that the chilling of the heating surfaces and interruption to the regular routine are hard on the boiler itself, and that hence, it should only be done when necessary and then as quickly as possible.

Stopping Suddenly.—With everything going along its regular schedule, suppose that the engine is suddenly stopped. The dispositions to be taken will depend on whether the stoppage is momentary or whether it is expected to last for some time. Here again the caution regarding a sudden change in the conditions must be kept in mind. If the stop is but momentary it will probably be sufficient to shut off the draft, close the dampers and put on the feed strong, standing by to ease open the safety valves in case the pressure rises too near the point of blowing off. If the stop is to be longer it may be necessary to still further check the fires by putting up the ash pit doors and opening the furnace doors. Caution must be exercised in thus checking the flow of air through the grates lest there be danger of overheating the bars, or even of bringing them down into the ash pit. Of these various steps for checking the fires the opening of the furnace doors and the sudden chilling of the heating surfaces is the most objectionable and should not be resorted to unless necessary. As an additional means the fires may be freshly coaled, especially with dampened coal. This will check the formation of steam and provide fuel for bringing them into good condition for the next start. A period of stoppage like this may also be taken advantage of to clean such fires as may be in need of it.

In addition to checking the formation of steam, that which is formed may often be used in a variety of ways. If evaporators are provided it may be turned on to them and thus go toward increasing the store of fresh feed water. The bilge pump may also be put on strong, and if its exhaust is saved there will be no loss of fresh water. In some cases with independent air and circulating pumps a bleeder is provided for taking the steam direct from the main steam pipe to the condenser. Here it is condensed and then sent by the feed pumps back to the boilers, thus avoiding blowing off at the safety valves and the loss of fresh water, and allowing the fires to be gradually reduced to the condition desired for the period of stoppage.

Here again in all of these operations general principles are often worth more than a multitude of minor directions. These principles are (1) *Sudden* chilling of the boiler heating surfaces must be avoided as far as possible. (2) Fresh water in the form of steam should not be wasted, and (3) Care must be taken not to allow the grate bars to melt down.

So far as relates to the general securing of the machinery and gear in the fire-room, the hints given in connection with getting under way will be a sufficient guide in reversing the process.

Supplementary Hints Relating to Water Tube Boilers.—In water tube boilers the circulation is usually more nearly natural than in fire tube boilers, and circulating devices are not, therefore, required. Steam may be raised in such boilers in from twenty minutes to one hour, depending on the type, character of the draft, etc. With this type of boiler it is especially necessary that for the best results the firing be light, often and regular, and that the fires be kept as nearly as possible in a uniform condition. It is also necessary that the feed be regular, and the water must be carefully watched, since from the small amount contained, any lack of feed in a given boiler will be followed by rapid lowering of the level, and by a rapidly increasing likelihood of danger to the tubes. In water tube boilers it is especially necessary that nothing but fresh water be used as feed, and great care must be taken to keep the condenser tight and the fresh water make up ample in quantity.

The tubes of water-tube boilers become coated with soot and ashes on the outer or fire side, and it is usually a very difficult matter to satisfactorily clean them without the use of a steam jet. In continued steaming for long periods, it will usually be found necessary from time to time to let the fires die down somewhat and to use what methods are available for blowing off and dislodging the soot from the tubes.

Coming Into Port.—When coming into port notice will usually be given some hours in advance, so that the fires may be worked into a condition in accordance with their expected disposition after arrival. If they are to be drawn and the boilers opened up for examination and

repairs, they will be allowed to burn down as low as possible so as to use no more fuel than necessary, and to leave as small an amount as possible to finally haul, while at the same time sufficient steam must be maintained to bring the ship safely to her anchorage or dock. If, on the other hand, the fires are to be banked, they will not be allowed to burn so low. It may be recommended to bank fires on the front of the grates, as in such case the air is heated as soon as it enters the furnace and the boiler is kept at a more nearly even temperature than if they are banked at the back of the grate. As the fires are banked they should be cleaned and enough fresh coal put on to hold them in the condition desired. If the fires are properly managed there will be little extra steam after the engines are stopped, and this may be readily disposed of by means of the evaporator, bilge pump, bleeder, safety valve, etc. Loss of fresh water at this time is of course less objectionable than when on the voyage, and if desired the steam may all be blown off through the safety valves. Many engineers, however, object to using the safety valves and escape pipe for this purpose except as a last resort, and prefer other means as mentioned. In passenger vessels the noise occasioned is usually considered objectionable, though to obviate this a muffler is frequently fitted in the escape pipe.

If the boilers are to be opened fires are allowed to die out or are hauled immediately. If time permits the former plan is preferable as the change in the condition of the boiler is more gradual. When the fires are finally hauled and the furnaces, back connections and tubes cleaned out, the ashes, soot and clinker are wet down and piled away until they can be disposed of to the ash barge, as few harbor regulations allow the dumping of ashes overboard. In wetting down the fires after they are hauled out on the fire room floor, or in wetting down ashes at any time, care should be taken not to wet the fronts of the boilers or the mouths of the ash pits. The local chilling will not improve the quality of the boiler and furnace plates, and the alternate wetting and drying will increase the opportunities for surface corrosion. For the same reason damp ashes should never be piled up in contact with the boiler or furnace plates, as in many instances serious corrosion has resulted from a neglect of this precaution.

The fires being burned out or hauled, some engineers proceed to blow the boilers down immediately. This plan, however, cannot be recommended and should not be adopted unless the time available for examination and repairs is so short as to make it absolutely necessary. It is far better to let the steam condense and the water gradually cool, and then draw it out by means of a pump, or in some cases run it into the bilge. In this way the boiler cools more gradually and the structure is left in better condition, while on the water side the scale and incrustation will usually be made softer and more easily removed than when the boiler is blown down with steam on.

It is estimated that the mercantile and naval tonnage now building in the United States represents an aggregate value of $69,000,000, exclusive of armor and guns for naval vessels. This represents nearly one dollar per *capita* for the population of the United States.

ENGINEERS' DICTIONARY.—XXX.

Oil.—Material used for lubricating the moving parts of machinery. For the various rubbing surfaces and turning joints, except within the cylinder, olive oil, castor oil, and the lubricating grades of mineral oil are used. Olive oil when pure is a most excellent lubricant, especially for machinery of moderate or light weight, but it is liable to adulteration by peanut oil or other oils of an inferior quality. For the internal surfaces of steam cylinders, nothing but the best mineral oil must be used. The grade commonly employed is known as *cylinder oil,* and is heavy and viscid at ordinary temperatures, becoming quite fluid, however, at the temperature of the steam.

Oil Cup.—A cup for holding oil, and from which it is fed to the point where it is required.

Oil Pipe.—A pipe for conveying oil from a source of supply to a more or less distant point where it is delivered to a bearing surface.

Packing.—In general, any material used for making a steam or water-tight joint. As regards the packing, joints may be divided into two classes as follows: (1) Fixed joints as those between a cylinder or valve chest cover and flange, and (2) sliding or slip joints, as those between a piston-rod or valve-stem and the stuffing box.

For stationary joints a great variety of packings are in use, the difference depending to some extent upon the temperature to which the joint is to be subjected. Thus for joints to stand high temperature as with boiler manholes, cylinder heads, etc., sheet asbestos, either plain or in combination with other materials, is used. There are also various kinds of packing in which rubber in one form or another is used, either in combination with some fibrous material as sheet canvas, or as a constituent of some form of compound. The tendency of rubber by itself is to grow dry, hard and brittle, especially under the action of heat, and the purpose of the modern forms of rubber compound is to avoid this tendency, at the same time retaining its elasticity and joint-making qualities. For joints not subject to a high temperature, similar forms of packing are used, though with a greater proportion of rubber if desired. The strip or ring of packing which is cut out and fitted for the joint is called a *gasket.* In addition to such materials, joints are also made with gaskets of corrugated sheet copper, or of plain copper wire. For high pressures such gaskets have proved quite successful. The soft copper is expanded between the harder metals of the flanges, and spreads, filling the surfaces where it touches, thus making a tight joint.

For sliding joints the greatest variety of packings is also in use. They may be divided broadly, however, into the two classes, fibrous and metallic. The fibrous packings are made of the same material as the sheet packings above described, but are either round, square, or triangular in section. For use they are cut to such lengths as may be necessary, and placed in the stuffing box in layers or turns, the joints between the ends being shifted so as not to come one above another. For description of metallic packings see under that head.

The Russian cruiser Variag is reported to have made a speed of 24.22 knots on her preliminary trial on July 25.

THE ART OF MAKING MECHANICAL SKETCHES —FOR MARINE ENGINEERS.

BY PROF. C. W. MAC CORD.

We proceed now to consider a second method of making drawings which in one view not only exhibit the three dimensions, but at the same time show certain systems of lines in their true lengths, so that all may be measured by the same scale. The principle of this new process will be clear by the aid of Fig. 55, in which

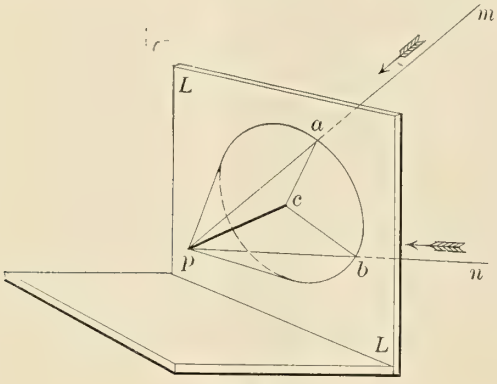


FIG. 55.

L L is a vertical glass plate representing the picture plane. Let *c* be a point in this plane, and *c p* a line perpendicular to it. Also let *p m* represent a visual ray, making an angle of 45° with the plane *L L*, and piercing it at *a;* then *a c* is the projection of *p c* upon the picture plane—and it is equal to *p c*, because the angles *c a p*, *c p a*, are each equal to 45°.

Now imagine the eye to be at an infinite distance in the direction *p m;* then all the visual rays will be parallel, and all lines perpendicular to the picture plane will be represented upon that plane by lines of their actual length, and parallel to *a c*.

The fact that the projection *c a* is equal to the line

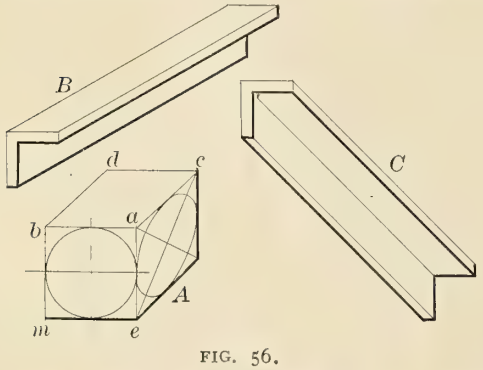


FIG. 56.

c p, depends upon the condition that the projecting lines make angles of 45° with the picture plane; but the *direction* of the projection depends upon that of the visual ray. Thus, supposing the eye to be still at an infinite distance, but in the direction *p n*, the projection will still be equal to *c p*, but it will have the direction *c b;* in short, if *c p* be the axis of a cone of revolution whose angle at the vertex *p* is 90°, the projecting lines may be parallel to any element of that cone.

Any line which lies in the picture plane is, of course, its own projection; and in representing, for instance, a cube, as at *A* in Fig. 56, we may assume its nearer face to lie in that plane, thus appearing as a square of its true size. From what precedes it follows at once that the edges perpendicular to *L L* may be represented by lines of their true length, but having any direction at pleasure; we can therefore show in addition to the front or nearer face, either the right face or the left, the upper or the lower, as may best suit our purpose. And either of these two faces may be made the more conspicuous by proper selection of the angles, as shown by the representations *B* and *C*, which are merely different drawings of the same angle iron upon the same system.

And this is a system of true *oblique projections;* the projecting lines are all parallel, since the eye is infinitely remote; but instead of being perpendicular to the picture plane they make with it a given angle less than 90°—which has so far been limited to the arbitrary value of 45°. This mode of representation is obviously more flexible than the isometric system, by reason of the freedom of choice as to the direction of the receding lines. And it is always as easily constructed as the other; and in many cases more so, owing to the fact that whatever is parallel to the paper is seen in its true form and size; thus the circle inscribed in the nearer face of the cube in Fig. 56 is more readily drawn than the ellipse which represents a circle in any isometric plane, and the circumstance that the right angles in the front face and all planes parallel to it are represented by right angles, unquestionably facilitates the execution. Nevertheless there is an apparent distortion, just as there is in the application of isometry, but of a different kind. For the purpose of comparison, we have in the following figures drawn in this manner some of the objects represented in the preceding article, of the same dimensions and on the same scale. Thus the reader may judge for himself of the relative advantages of the two systems by comparing Fig. 57 with Fig. 45; Fig. 58 with Fig. 46; Fig. 59 with Fig. 52, and Fig. 60 with Fig. 54.

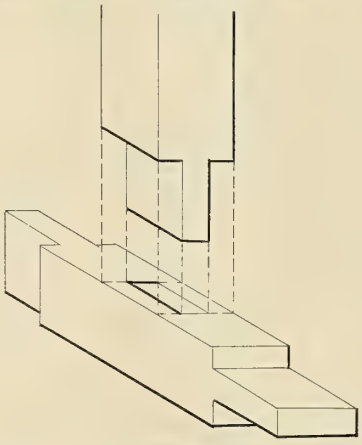


FIG. 57.

This method of representation is known as "Cavalier Projection," and also as "Cabinet Projection," and is exceedingly convenient in making sketches; in many cases also, drawings thus made, by reason of their showing three sides of an object in one view, are actually more effective—seem more explanatory and easily read, than ordinary plans and elevations, even to those who are familiar with the latter.

The determination of lines which are neither parallel nor perpendicular to the paper, is effected by means of "offsets," very much as in isometric drawing. Thus in Fig. 61 is shown a rectangular prism, surmounted by an irregular wedge. The line *e d* is parallel to the paper, and being horizontal, is also parallel to *a g*. To locate it, we may set off *a b* on *a g*, equal to the distance of *d* from the plane *a m*, then draw *b c* parallel to *a o* and equal to the distance of *d* from the front plane, *a n*, and at *c* set up the vertical line *c d*, equal to the distance of *d* above the plane *a l*. Otherwise, we may erect *g h*, equal to *c d*, draw the horizontal line *h k* equal to the distance of *e* from the plane *g i*, and then draw *k e* parallel to *a o* and equal to *b c*, thus locating the point *e*.

In regard to the pictorial effect, it will be noted that the apparent distortion varies considerably with the nature of the subject, and it will be found that while in some cases there is little to choose between the two systems, in others one is decidedly preferable to the other. Thus the objects represented in Figs. 57, 58, and 60, appear equally well when drawn in either manner; probably few will question that the isometric drawing of the partly opened box is superior in effect to the Cavalier projection; and the attempt to represent by the latter method the die and matrix shown in Fig. 50 would result in something hardly intelligible. Unfortunately, there is no rule by which to determine which system

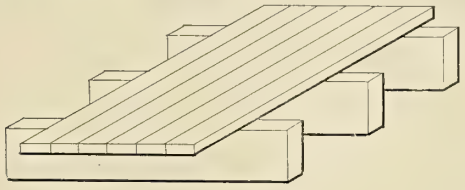


FIG. 58.

to use in any given case; that must be decided by judgment guided by experience and possibly aided by experiment.

In Fig 62, the drawing *A*, at the left, is a rather peculiar isometric representation of a crank. The isometric axes are *c a, c b, c d;* of which *c b* is horizontal. Consequently, *c g*, the longer diagonal of the rhombus circumscribing the isometric circle of the shaft, is vertical. And the peculiarity consists in this, that *o r*, the centre line of the nearer face of the crank, coincides with *c g*. Clearly, *m n*, the major axis of the isometric circle of the shaft, is greater than *c e* the true diameter: and the result is, that while *x*, *y*, and *z*, the thickness of the web and the lengths of the hubs surrounding the shaft and the crank-pin respectively, are set off in their true lengths because being parallel to *a b*, they are isometric lines; *o r*, the length of the crank, and all lines parallel to it, must be drawn longer than they actually are, in the proportion of *m n* to *c e*. On the other hand, the breadth of the web at any distance from the centre of the shaft, measured horizontally across as at *t*, will be less than the true breadth, in the same proportion that *k l* the minor axis of the isometric circle of the shaft, bears to *c e* the real diameter.

At *B*, on the right of Fig. 62, is shown a Cavalier projection of the same crank to the same circle, and while it must be admitted that when instruments are used in making a sketch, this can be made in much less time than the other, yet *A* presents a much more pleasing appearance, and has a less outrageous apparent distortion. In purely free-hand sketching, probably most persons would take *A* rather than *B* as a model, since an ellipse is more easily drawn by the eye than a circle is; and inasmuch as the dimensions would in either case be figured in, no objection could be made to this selection.

For pictorial representation in an accurate drawing, again, there is no question that *A* is preferable to *B*, by reason of the less distortion, at least for objects of

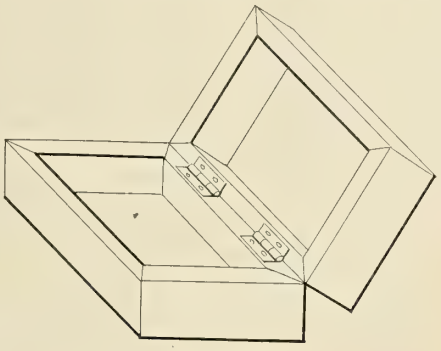


FIG. 59.

this description; but the construction involves the use of two scales for horizontal measurements, of which the units are *c e* and *k l*, and another for vertical measurements, having *m n* for its unit.

A reason for this freedom from distortion may possibly be found by reference to the drawing of the cube *A*, in Fig. 56; where the lines *a c, c d*, although really equal to *a b*, appear much longer; and the distortion is excessive, because of a mental recognition of the fact that they would in fact *appear* shorter than *a e* or *a b*, in looking at a cube from any accessible point of view, because *a c* and *b d* are parallel lines receding from the plane *a m*,—being in this case perpendicular to it. In short, the eye recognizes that receding parallels seem to approach each other, and that equal spaces measured upon such lines appear smaller as their distances from the eye increase; this, so far as our senses are concerned, is wholly a matter of observation and experience, although it can be mathematically shown that it should be so.

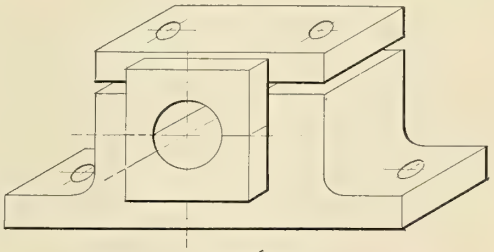


FIG. 60.

Now returning to *A* in Fig. 62, it is at once recognized that the measurements *x*, *y*, *z*, are in directions perpendicular to the front face of the crank; and being set off in their true length, they appear less in proportion to *o r*, which is greater than the true length of the crank.

In certain cases at least, then, the distortion of isometric drawings may be reduced for pictorial purposes. And it seems worth while to see what can be done in this direction with oblique projections. Referring to

Fig. 56, it is seen that the drawing of the cube, at *A*, is distorted to an oppressive degree: and so long as it is insisted that the three edges *ab*, *ae*, *ac*, shall all be set off by the same scale, it will be found that no change in the direction of *ac* will diminish that distortion. In order to retain the specific name of "cavalier" projec-

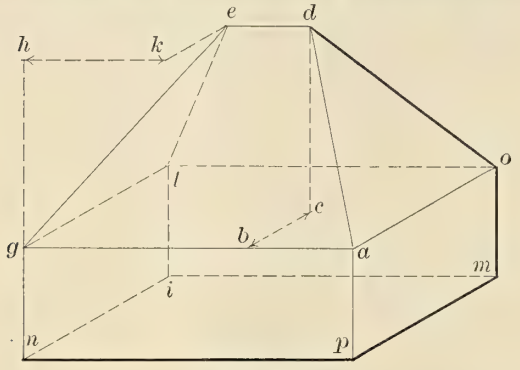


FIG. 61.

tion, it is imperative that these edges shall be drawn of the same length; which requires the projecting lines to make angles of 45° with the picture plane, as shown in Fig. 55. But if in that figure we prolong *cp*, making it, say, twice as long as at present, still retaining the actual lengths of *ca* and *cb* as they are, the effect of this will be that the projecting lines will make with the picture plane an angle greater than 45°; also, *ac* will be the projection of a line twice as long as itself—so that the projection of a line perpendicular to the picture plane, as *ac* or *bd* in Fig. 56, will be only *half* as long as the line itself.

A representation of the cube made in this manner is given in Fig. 63; the apparent distortion is obviously very much reduced—so much so, in fact, that for pictorial purposes it may be accepted as a not altogether

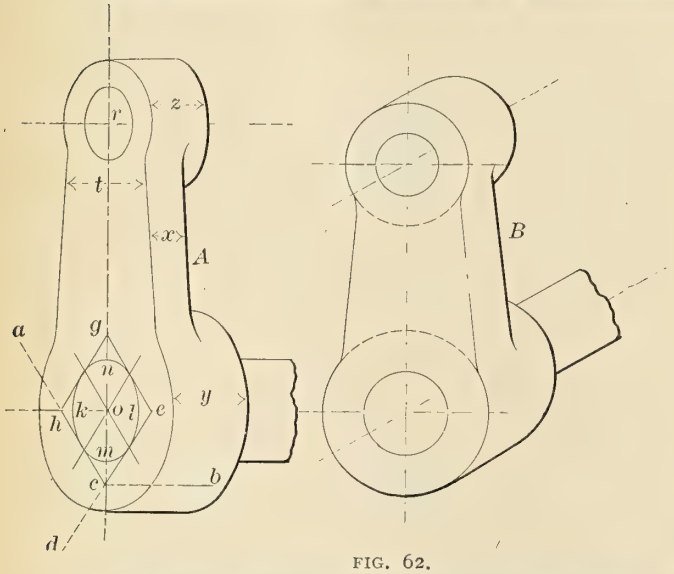


FIG. 62.

objectionable substitute for a perspective drawing. In this connection it may be remarked that even an accurately constructed perspective, particularly of a machine, more often than not fails to satisfy the eye and to "look natural." This is less noticeable in the case of architectural subjects, probably because the eye is there usually taken at a very considerable distance from the picture plane. But doubtless one reason, if not the chief one, of the stiff and constrained appearance, is that in the mathematical process of construction the eye is regarded as a single point, and no account is taken of the phenomena of binocular vision. But if the observation be made through a pin-hole placed in precisely the right place, all the distortion disappears, and an almost stereoscopic effect of relief is produced. We have never seen any directions for constructing a perspective drawing to be looked at with two eyes; indeed, it is sufficiently laborious to construct it for a one-eyed man, which may excuse this digression, and the attempt to produce a projection which shall not be too distressingly distorted and out of drawing.

Accepting Fig. 63, then, as the result of this attempt, it is to be pointed out that the ellipse representing the circle on the side face of the cube may be constructed in a manner analogous to that employed in Fig. 47, except that as the circumscribing parallelogram is not a rhombus, its diagonals are not perpendicular to each other, and do not coincide with the principal axes of the

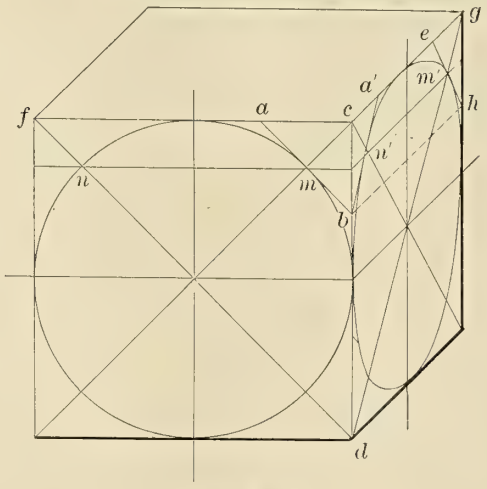


FIG. 63.

ellipse. But eight points in it are readily located as in Fig. 47: and the tangents *ba' he*, are also readily determined, recollecting that *ca' ge*, are each equal to one-half of *ca*. The sides of the parallelogram are, of course, tangent to the ellipse at their middle points, as before; and by the aid of these eight points and their tangents, the curve can readily be traced with the free hand accurately enough to enable the operator to ink it in at once by the use of the curved rules or sweeps.

The inclination of *cg* to the vertical side *cd*, in Fig. 63, is 45°; but of course any other direction may be given to it; and if for any reason it should be desirable, *cg* may be drawn of one-third, one-fourth, or, indeed, any fraction at pleasure of its true length.

COAST DEFENSE GUN.—There is now under construction at the Watervliet Arsenal, New York, a 16-in. breech loading rifle, which is to be mounted in a Gruson turret at Sandy Hook at the entrance of New York harbor. The gun is nearly 50 ft. long over all, and more than 6 ft. dia. at the breech. The gun, when complete, will weight 126 tons. One of the lathes used in the manufacture of this gun weighs 250 tons, is 135 ft. long, and has a swing of 9 ft.

TECHNICAL PUBLICATIONS.

THE STEAM ENGINE INDICATOR. By Cecil H. Peabody, Professor of Marine Engineering and Naval Architecture, Massachusetts Institute of Technology. First edition. John Wiley & Sons, New York. Size, 5 by 7 1-2. Pages 153. With many illustrations. Cloth, $1.50.

This book treats the subject of the steam engine indicator in somewhat different form from most of the literature on that subject. It starts with a very complete description of all the modern instruments used in this country, and illustrates each with accurate engravings, showing their internal construction, the individual parts, and methods to assemble them. The adaptation of the instrument to gas engines and ammonia compressors is explained, and valuable hints given on attachments. The method of attaching the piping to the cylinders of the engine as well as the different styles of reducing gear are shown and explained. The errors which are liable to occur in the instrument itself are also pointed out.

Then follows a description of the different styles of planimeters, the principle of their construction and the method of handling them. The next section is devoted to indicator cards, showing the errors which are liable to occur owing to faulty handling of the indicator, also cards taken from simple, compound, and triple expansion engines, gas engines, ammonia compressors, and pumps. The usual tables of areas, properties of saturated steam, etc., are appended.

A great many engineers on vessels, who have not had the advantage of a technical training, are aware of the importance of the indicator, and in many cases are able to decipher an indicator diagram, or at least its most important features. The instrument itself, however, and the handling and attachment of the same, is often a stumbling block. It is often complained that there is no literature on the subject which engineers can readily understand, as most of the books give but little attention to the instrument itself, and then usually some antiquated type, but devote the larger amount of space to abstruse considerations of the results to be obtained from the use of the instrument, into which the reader is frequently unable to follow the author. In this respect Professor Peabody's book will be very welcome both to the practical engineer as well as to the student, as all the computations can be understood by any one having an ordinary school education.

JAHRBUCH DER SCHIFFBAUTECHNISCHEN GESELLSCHAFT (Proceedings of the German Society of Naval Architects and Marine Engineers.) Berlin, Julius Springer. Size, 8 by 10 1-2 in. Pages 435. With many cuts and folding plates.

Naval Architects and Marine Engineers have awaited with interest the appearance of the volume which now lies before us.

When in 1899 it was announced that the German members of these professions had formed a society along the lines of the great parent society, the English Naval Architects, the announcement was received with lively interest, and it was realized that this was but another and logical step in connection with the astonishing strides which Germany has made in shipbuilding in the past decade.

The present volume, the first we trust of a long series, comes fully up to the high expectations which we may have justly formed. Of no small interest is the account given in the introductory pages, of the steps leading up to the organization, lists of members, etc. It appears that the initial list of members numbered 432, gathered from all parts of Germany. The Society is thus seen to start in under the most favorable auspices, and with a list of membership which, both in quality and quantity, may well authorize us to expect much from its future proceedings.

The present volume contains but seven papers, all, however, of high value. The list is as follows:

Modern Submarine Boats.....C. Busley
Application of Wireless Telegraphy to Marine Purposes .....A. Slaby
Steering Apparatus, especially for the latest large ocean liners.....F. L. Middendorf
The Development of the Armor-Plated Ship of the Line.....Johs Rudloff
Investigations into the Periodic Variations in the Angular Velocity of the Main Shaft..G. Bauer
Resistance of Ships and Estimates of Power. F. L. Middendorf
Strength Computations for Ships.....C. Radermacher

The paper on submarine boats is historical and descriptive, and traverses in a thorough manner the development of this form of offensive craft. Their advantages and disadvantages are considered, and the general conclusion is drawn that Germany does well to leave aside the building of boats of such doubtful availability, and to restrict herself to battleships, cruisers, and torpedo craft.

The paper of Dr. Slaby discusses in an interesting manner the possible application of wireless telegraphy for marine purposes, with due note of the limitations under present conditions.

The paper on steering apparatus is of especial note, by reason of the importance of the subject and the completeness with which the ground is covered. The subject is treated first from the historical standpoint, and then the whole ground of modern appliances, especially those used in large ocean steamships, is completely traversed. The paper, which covers 123 pages, is supplemented by a large number of cuts and full-page or folding plates, making as a whole a most valuable and complete presentation of the subject.

The paper by Rudloff is historical and critical, and treats the development of modern armor-clad ships in an interesting and instructive manner.

The paper by Bauer is of great interest and value, as giving much needed information and new light on a subject where little has hitherto been done. The causes for variation in the rate of turning of the main shaft are discussed, and experimental investigations on the subject are described and the results given.

The paper on resistance and power estimates is an important contribution to the subject, seeking, as it does, to develop relations between actual trial results and relatively simple formulæ. A large number of trial results are given as the basis of the discussion,

and these form a collection of data of no small value, independent of their relation to the formulæ under discussion.

The paper on the strength of ships presents the general theory of this subject in a simple manner, and describes methods for determining in the most convenient way the curves of net load, shear, and bending movement. The paper is illustrated with a number of cases, drawn apparently from practice, and serving as interesting examples of such methods and computations.

The volume is well printed and bound, and the illustrations have also received careful treatment. As a whole, the volume is an excellent example of the bookmaker's art, and is worthy of the high character of the material which it contains.

PAPERS PRESENTED AT THE PARIS INTERNATIONAL CONGRESS OF NAVAL ARCHITECTS AND MARINE ENGINEERS.

Advance copies of most of the papers of the French Congress of Naval Architects and Marine Engineers are now at hand, and furnish an excellent idea of the general character of the programme for the meeting. This Congress is held under the auspices of the "Association Technique Maritime," the French Society of Naval Architects and Marine Engineers, and the efficient secretary of the latter society, M. Hauser, serves as secretary for the Congress.

One of the interesting features of recent international expositions has been the "congresses," or meetings, which have been held for the discussion of matters connected with almost every form of human activity. The possibilities for good in these opportunities for the interchange of thought, purpose, principle, method, etc., especially among different nationalities in the same field of activity, are not likely to be overestimated, and it is a matter of congratulation, both at Chicago in 1893 and at Paris in 1900, that the interests of those concerned with marine construction in all its branches have been so well provided for.

The present Congress brings together representative and leading Naval Architects and Marine Engineers from all countries having maritime interests, and the papers presented and the discussions which they provoke may be properly expected to furnish a series of notable contributions to the literature of the subject.

It will be recalled that the list of papers, so far as in the hands of the secretary at that time, was published in MARINE ENGINEERING for May. The list of advance copies contains several additional papers, making a total of thirty-one. These are divided as follows among the different nationalities: French, 16; English, 4; United States, 3; German, 2; Russian, 2; Austrian, 1; Dutch, 1; Italian, 1; Swedish, 1. Compared with the Congress held in Chicago in 1893, the papers are somewhat less numerous, and in the main somewhat shorter, so that unless large additions are made to the present list the proceedings as a whole are not likely to be as bulky as those of the Chicago Congress.

Regarding the papers themselves, they may be properly characterized in the main as of high quality, though there are perhaps few of the very first order of importance.

Among those of especial interest from the theoretical standpoint, mention may be made of the paper by Afonassief on the Resistance of Ships, and of that by Rateau on the Theory of the Screw Propeller.

Of especial practical interest are papers by Moissenet on Tugboat Equipment, by Berling on the Vibrations of the German Cruisers *Hansa* and *Vineta*, and by Croneau on the Electric Equipment of the Cruiser *Rainha Da Amelia*. Of combined theoretical and practical interest are the papers by Doyère on the Test of a River Steamer with Multiple Screws, and by Bertin on the Stability of a Steamer After Bilging of Compartments by Collision at Sea.

Limitations of space prevent detailed reference to these or to many other papers, but the list so far in hand promises a volume of proceedings as a whole which will be of high value to all interested in these subjects, and which in many ways will well serve to show the present actual condition of marine construction, both as a science and as an art.

QUERIES AND ANSWERS.

(Communications intended for this department will not receive attention unless accompanied by the full name and address of the sender, which will be considered confidential.)

Q.—To settle an argument, will you please say whether "Work and Power" are one and the same, or if there is any difference, what is it? L. R.

Force exerted through space is *work*, and the work is measured by the product of the force and the distance Work, however, is not the same thing as power. The latter contains the *time* element and the unit of power is defined as a certain amount of work done in a unit time. If a force of 40 lb. acts through 30 ft. the amount of work done is 1,200 ft. lb. The amount of power developed will depend altogether upon the time employed. If the time is 1 minute the power will be about 1-27 horse power, while if the time is 1 second the power will be slightly over 2 horse power. When we pay for work by the job we pay for the *work* done; when we pay for work by the day we pay for the *power* exerted or used.

The board which has had under consideration the site for the new $1,000,000 drydock for the Brooklyn Navy Yard has recently completed its work, and it is understood that the Whitney Basin site is the one agreed upon. Actual work on the dock will not be begun for about two months. In the meantime the authorities of the yard are urging the Secretary of the Navy to permit the work to be done by the yard force instead of by contract, as this would furnish so satisfactory a solution to the problem of lack of work for the regular force of employees.

The large American steam yacht *Atalanta*, built for the late Jay Gould, has been sold to the Government of the United States of Colombia, and will be converted into a gunboat. The *Atalanta* was constructed in 1882 at the Cramps yard, and was at the time the largest yacht in the country. It is understood that the interior fittings will be left intact, as she will be used by the higher officials of the Colombian Government, though ready at all times for service as a gunboat.

It is reported on good authority that the Cunard line has ordered two new steamers for its Boston passenger and freight service.